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SEED CERTIFICATION.

A REVIEW OF BENEFITS AND COST UNDER THE NEW ZEALAND SYSTEM.

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IT is five years since the Department of Agriculture inaugurated seed certification, and a review of the position in the light of our present experience seems opportune. We should now be able to state fairly definitely whether the objectives at which we aimed are being attained, and whether the cost of attainment is justified.

Most countries enact legislation which aims at protecting the consumer against misrepresentation of quality. This applies more particularly when the consuming public have no ready means of determining quality, as in the case of milk, butter, bread, and other foodstuffs, and fertilizers, leather, linen, and woollen goods. The purchase of seed has always presented a difficulty to the farming community, and seed certification is essentially an endeavour to protect the consumer. Many countries have established seed laws which aim at protecting the buyer and regulating internal and external trade by establishing standards of seed purity, germination, and sometimes bushel weight. Since seed legislation of this kind affords one means of protection, and seed certification another, it seems desirable that we should, in the first place, consider their respective merits.

We have in New Zealand no Seed Act. In other countries it would appear that the enforcement of such Acts is costly, while they are difficult to administer, and not always effective. The following is an opinion expressed by C. N. Smith, counsel for the American Seed Trade Association, writing on American seed laws, as published in the *Seed World* of 10th June, 1932 :—

> The success of this American seed legislation can perhaps best be stated by referring to a heretofore unpublished report of the Committee on Seed Law Enforcement of the Seed Council of North America, dated 4th December, 1930, and based on data obtained from answers to a questionnaire addressed to officials and seedsmen in the 47 States having seed laws. In the opinion of the official administrators of these seed laws, reporting from 38 States, 20 State seed laws were fully enforced, 14 laws partially enforced, and 4 unenforced. The seedsmen, reporting on 25 State laws, say that only 5 laws are fully enforced, 17 partially enforced, and 3 unenforced. While these reports neither cover all the State seed laws, nor show unanimity of ideas, due to viewing the situation from different

angles and through different spectacles, these seed laws have, in the writer's opinion, undoubtedly performed a considerable service in educating both the seedsmen and the planters in the economic value of good seeds. The unfortunate failures of many of these laws are equally obvious. First, the laws which depart from the principles approved by technical experts and practical seedsmen cannot give adequate protection to any one, seedsman or planter. Such laws must be revised, and, let us hope, along the lines of uniformity. Second, the Legislatures have failed, in nearly every State, to provide sufficient revenue to execute these laws. An unenforced law creates in the planter false hopes of protection, fatal competition to the responsible seedsmen from tricky dealers, and a general contempt of all law.

Seed Quality.

Seed legislation aims at "seed quality," but very rarely does it embrace more than a part of what might be included under this term. Primarily it aims at seed purity and germination, sometimes at bushel weight, colour, and size. Upon these factors the value of the seed is based. Attractive appearance is a very strong selling-point, yet one which is very misleading and may have originated from popular prejudice. Crested-dogstail seed affords a case in point, the commercial attitude in this country being that the seed should be of a bright canary yellow. Jacques has shown, however, that "the colour of crested-dogstail seed becomes darker with maturity, and coincident with this there is a greater vitality and better germination," also "that in order to obtain a uniformly light-coloured sample, a sacrifice of seed-vitality, germination-capacity, and weight has to be made."

Again, many diseases are seed-borne, yet it is difficult and often impossible to detect seed-borne disease by seed inspection. Under such circumstances two avenues of approach are available. Either the seed crop from which the seed was harvested must have been inspected and the degree of infection determined, or a representative sample of the seed must be grown to determine the degree of infection carried by the bulk.

Finally, and most important of all, the seed carries those hereditary factors which predetermine the type of plant that will arise. It is not possible here to enlarge upon the importance of strain in rye-grass, clover, cocksfoot, and many other seeds. This has already received a great deal of publicity; but it must nevertheless be emphasized that these strain differences, which are so striking in the growing plant, are difficult if not impossible to determine in the seed itself. The seed carries all those potentialities of performance, but itself gives little information on these points. To quote Professor Stapledon: "Mere cheapness and even superlative germination are to be regarded as secondary, and not primary, excellencies, for unless the strain and variety are correct for a particular use in a particular place, the sowing of seeds, in themselves perfect, will avail little or nothing."

We have then to consider what seed legislation can be devised that will embrace all these factors which, in their summation, may be described as "seed quality." Failing seed legislation, how can we best exploit the economic possibilities of findings relating to purity, vitality, seed-borne disease, and strain?

Certification adopted as the Means.

The New Zealand Department of Agriculture has adopted seed certification as a means to the end just stated. As an impartial judge

it determines quality, and seals and tags those seeds which attain to certain definite standards. With this end in view the crop from which the seed is to be harvested has to be inspected. Generally an even more searching test is necessary, and a sample of seed from the crop or pasture in question is grown under trial before any produce from that area is accepted as eligible for certification. These inspections and trials have reference to type, performance, and freedom from disease.

Secondly, the Department has to make certain that the seed of a particular area, and no other, is certified at threshing, and later at machine-dressing. This necessitates official supervision of these operations, and the sealing and tagging of the sacks containing this seed.

Finally, the purity and germination of each line of seed is determined by the Government Seed Analyst from an officially drawn sample. A certificate embodying this information accompanies each line, and the one can be identified with the other since both the tag on the sack, and the purity and germination certificate, carry similar identification marks.

Such is the system adopted in New Zealand to meet the requirements of the seed trade, to ensure that the grower receives seed which is

New Zealand Seed Certification.

Seed.	Chief Consideration upon which Certification is based.	Acreage inspected each Season.					
		1927–28.	1928–29.	1929–30.	1930–31.	1931–32.	1932–33 (approx).
Potatoes ..	Varietal purity, cropping-power, and freedom from virus disease	821	909	1,200	1,334	1,146 (1)	1,200
Wheat ..	Varietal purity and freedom from loose and stinking smuts	473	1,184	2,277	3,289	1,063 (2)	2,000
White clover	Age of pasture. This was changed in 1931–32 to a standard based on type	..	325	664	311	31 (3)	Not available.
Perennial rye-grass	Genuine perennial type conforming to certain standards of purity	..	..	3,028	6,539	9,709	23,000
Brown-top ..	Freedom from red-top (*Agrostis palustris*)	..	..	22,000	24,901	18,297 (4)	Not available
Cocksfoot ..	Type as exemplified in the produce of Banks Peninsula	..	..	..	..	4,226	Not available.
Totals ..	..	1,294	2,418	29,169	36,374	34,472	..

(1) The preceding season had been one of unprecedented low prices.

(2) The introduction of more stringent regulations was the cause of this reduction.

(3) Reduced area due to alteration of standard from one of age to one of type.

(4) Reduction due to introduction of per-acre charges, growers entering only the best areas. Actually a greater quantity of seed was harvested from this area than from the larger area in the previous season.

correctly described, and to lift from the shoulders of vendor and purchaser a part of the responsibility connected with the sale and purchase of seed.

The essential difference, then, between the commonly formulated seed legislation and seed certification will be appreciated. Seed certification has a wider sphere. It embraces a greater range of factors which make for seed-quality. It is more lasting in its effect, since it deals also with hereditary factors of variety and strain which are transmitted from year to year and from farm to farm. It checks the spread of disease and distributes better seeds, which result in better crops. Slowly at first, but inevitably and more rapidly, the unprofitable type of crop will be replaced by those that are more productive.

On the other hand, seed certification handles at present only a part of the seed used in this country. Some may view seed legislation as still desirable in connection with seeds not subject to certification. If it is true, however, as C. N. Smith has expressed, that the main benefit to be derived from seed legislation lies in its educational value and in giving publicity to the question of seed-quality, then we have in seed certification an even better medium of education since it has a wider conception of the term "seed-quality."

Seed certification was commenced with seed wheat and seed potatoes in the 1927–28 season. Subsequently other seeds were included, and the accompanying table (preceding page) gives some idea of the progress that has been made since its inception.

During the 1931–32 season the certification of New-Zealand-grown Montgomery Red clover and Kentish Wild White clover was inaugurated, and a number of areas are now under certification.

Cost of Seed Certification.

This steady increase in the volume of work has resulted, of course, in increased expenditure. For four years seed certification remained a free service, but commencing with the 1931–32 season charges were imposed for the first time upon both producer and merchant. It was anticipated that this action might restrict activities, but such has not been our experience. Certainly the introduction of charges coincided with a reduction in the total area inspected, but these reductions could in each case be accounted for as the direct result of other causes which are explained in the footnotes to the foregoing table. In point of fact, the introduction of charges seemed rather to stimulate interest and created a better realization of the value of the services rendered.

Certain of the charges are calculated on an acreage basis and cannot be converted readily into *ad valorem* percentages. Nevertheless, the following figures are very close approximations of the percentage value of the product collected by way of fees in 1931–32:—

	Per Cent.		Per Cent.
Rye-grass ..	.. 1·6	Cocksfoot ..	.. 1·6
Brown-top ..	.. 1·8	Seed potatoes	.. 3·6
Red clover ..	.. 1·25	Seed wheat ..	.. 3·5
White clover	.. 0·6	Seed beans ..	.. 3·0

Notes.—The actual cost of cocksfoot-seed certification on Banks Peninsula amounted to about 1·6 per cent., of which 0·8 per cent. was received by the Department; the balance was collected and held by the Akaroa Cocksfoot Seed Growers' Association. The low cost in the case of white clover is explained by the very high price of this seed during the 1931–32 season.

The bulk of the 1931–32 season's receipts of charges in connection with certification have now come to hand and represent approximately 1·7 per cent. of the value of the seeds certified. The amount collected covers all expenditure in travelling-expenses, seals, printing, and stationery. This is satisfactory in view of the fact that the charges were devised to cover just this expenditure. Apart from this, however, must be considered the salaries paid to Departmental officers undertaking field inspection, sealing and tagging, &c. When all expenses are taken into account, the total cost of certification has amounted to approximately 3·2 per cent. of the value of the seed certified. Salaries paid to departmental officers account for one-half this cost. These salary charges are borne by the Department and represent its present share towards the cost of certification. Whether the Department should bear part or all the burden of salaries paid to its officers when performing these duties is a matter of policy, but certain aspects of the question are discussed later.

To summarize the position, certification cost 3·2 per cent. of the value of the products certified. Approximately one-half of this was paid by the merchant and grower, and one-half by the Department. No one claims the present organization to be perfect; improvements will be effected, and with an increase in the volume of work there is every reason to anticipate a substantial reduction in percentage cost. It must be apparent, however, that with fixed charges, and seed prices fluctuating from year to year, the percentage cost will vary inversely to the price. In this connection reference has already been made to the anomalous position of white clover. The total value of the seed certified during the 1931–32 season is estimated at over £100,000. Were the Department to view its certification services as worth a commission of 3 per cent., it would collect by way of fees £3,000—a sum sufficient to have rendered seed certification self-supporting during the season under review.

Benefits received by the Several Interests.

This expenditure is borne by the producer, the merchant, the consumer or planter (who has to pay a premium on certified seed), and by the State. Is it justified? Are the benefits received sufficient to compensate for the cost? Each will be considered in turn.

The Producer.—The producer receives direct benefit in the enhanced price of his produce. This alone more than covers his cost. Certification gives his produce a hall-mark of quality. It advertises and standardizes his seed. It creates a demand, and as this demand grows, both within and without the Dominion, there will follow an expansion of trade both for him and for his neighbour.

The Merchant.—With few exceptions merchants have welcomed certification. For the few who have not it may be said that they hold perhaps some justification for their views. In most cases they specialize in the sale of one or more classes of seed, and have indeed spent years in establishing trade and in creating confidence with their clients overseas. They see in certified seed a more or less standardized article which can be sold as readily by one as another. They lose to some extent their prestige.

Apart from this, merchants have realized that certification has created, and will continue to create, an increasing overseas demand, always providing we proceed along sound lines and in a spirit of helpful co-operation. This demand is by no means problematical. A demand from overseas for our certified grass and clover seeds is here now. Moreover, it must be acknowledged that certification paves the way for smooth and reliable trade relations both within and without the Dominion. It is already becoming recognized abroad. To again quote Professor Stapledon: "The climate of New Zealand is admirably suited to grass and clover seed production, but she hardly exports on an average more than 10 per cent. of her production. The Dominion is, however, alive to the possibilities of this trade, and is rapidly organizing her seed production on a sound basis as regards both strain and inspection."

Following are extracts from the September, 1932, *Agricultural Gazette of New South Wales* in an article written by A. W. S. Moodie, Assistant Agrostologist:—

Pending the investigation of local strains, farmers in districts suitable for seed-production should sow areas of New Zealand Government certified perennial rye-grass. This has proved suitable to our conditions, and is the most desirable type on the market at present. On no account should the ordinary so-called perennial rye-grass of commerce be sown for seed-production purposes.

In establishing areas (of cocksfoot) for seed-production, it would be wise to sow "Akaroa" in preference to New Zealand commercial or Danish seed.

When establishing areas of this crop (white clover) for seed-production, sow in the autumn at the rate of 4 lb. per acre, using New Zealand Government certified seed. Portions of the coast and tableland districts are suitable for seed-production.

These are examples of opinion expressed by grassland experts. Viewing the matter from the position of the seed trade, the following extracts from an overseas trade catalogue make interesting reading:—

Certified True Perennial Rye-grass. — Fortunately, owing to research and methods of certification which have been carried on in recent years, particularly in New Zealand, it is possible to secure seed of true perennial rye-grass. Guaranteed British indigenous old pasture rye-grass strains are better and more persistent than ordinary types, and Certified Mother Seed Hawke's Bay and Poverty Bay and Certified First-Harvest and Permanent Pasture Seed from New Zealand are truly permanent, high yielding, hardy, persistent, and leafy strains.

Seed Supplies: Ever since New Zealand seed has been certified we have been importing supplies direct from that country, and are therefore direct distributors of Certified Mother Seed and First-Harvest and Permanent Pasture Hawke's Bay and Poverty Bay Perennial Rye-grass.

Cocksfoot.—It is possible to obtain from New Zealand a number of grades of cocksfoot seed, the best of which is excellent quality. One of the finest strains in existence is old pasture Akaroa (N.Z.). Seed of this strain is always available, but this season for the first time genuine Mother Seed direct from Akaroa old pastures has come under the certification scheme of the New Zealand Department of Agriculture, and certified seed is now obtainable.

Brown Top (Agrostis tenuis).—There are several strains of the *Agrostis* species —brown top, creeping bent, and red-top. Of these the genuine New Zealand brown-top (*Agrostis tenuis*) is the best, particularly for lawns, greens, and other places where a first-class fine even turf is required.

White Clover.—The true wild white clover is harvested by hand from extremely old pastures in the Weald district of Kent (England), and in certain districts of New Zealand a distinct and superior strain is saved. The genuine New Zealand strain is certified by the Department of Agriculture and sent out in sealed bags with certificate attached. These two strains are the best, and are to be recommended in preference to other and inferior types which are offered for sale at lower prices.

Finally, the handling of certified seed must lighten the load of responsibility resting upon the shoulders of the merchant. All there is to know of type, purity, and germination is furnished, and he is relieved of the necessity for crop inspection. Can we then doubt that trade facilities and trade expansion more than justify the expenditure involved ?

The Planter or Consumer.—Curiously, many of those who have given but casual thought to certification see little beyond the benefits derived by the producer, who scores in the matter of price. They overlook the fact that the planter reaps a benefit greater than any one else. One would have to write at considerable length to give adequate justice to the benefits derived by those who use certified seed. That is not possible here, but those who have seen the grass and clover trials at the Plant Research Station, laid down by the Agrostologist, cannot help being impressed by the wide difference in productivity between good and bad strains. This difference is outstanding, and may well be reflected in the field as the difference between profit and loss.

Consider for a moment the grazing trials now being conducted by the Department of Agriculture in Canterbury. During the first period, which covered approximately one year, a mixture containing certified perennial rye-grass afforded 126·8 grazing days for every 100 produced on the mixture containing ordinary perennial. During the second period of approximately eleven months the permanence of the certified seed commenced to operate, giving 147 days as against 100. Thereafter it may be assumed that the poor perennial will disappear as usually happens in Canterbury, and necessitate re-establishment. If this experience is multiplied by many thousands we may visualize the wasted effort of the past in sowing a permanent pasture with non-permanent rye-grass.

Those who have seen the potato-certification trials must be for ever convinced of the necessity for knowing the virus infection and cropping-power of a crop from which they obtain seed. Without such knowledge they are just as likely to purchase seed with a cropping-power nearer 2 tons than 10 tons per acre.

So the use of certified seed must inevitably result in increased production and decreased cost, and it is but right that the discriminating buyer should be able to procure that particular strain or variety he needs, and will be all the more ready to buy when he is offered officially certified seed.

The State.—It may seem precocious to regard certification, now in its infancy, as a factor in the national prosperity of New Zealand. But the future holds for this country bright prospects in seed-production, and since this production should be organized and based upon a broad conception of seed-quality, it would appear reasonable to suppose that seed-production and seed certification will progress together.

Whether the State should pay part or any of the cost involved in certification, and whether the charges now enforced will require amendment, are matters of policy outside the present discussion. It may be permissible, however, to draw attention to one or two aspects, apart from trade expansion already mentioned, which justify State expenditure, and should be considered in formulating charges for the future.

The Department of Agriculture has been established to foster our primary industries, of which seed-production is one worthy of support. Its instructional services are free, and certification affords an excellent medium of instruction and one through which the Instructor can reach at once both the merchant and the grower. As such it performs a useful service.

We in New Zealand spend a considerable sum in plant-breeding and selection. Lincoln College, Massey College, the Wheat Research Institute, the Plant Research Station at Palmerston North, and the Pure Seed Station, Lincoln, are all engaged in one or more phases of this work. The objective in every case is the production of improved strains. What is to be the destiny of these strains? Is the seed to be distributed haphazard to the farmer with the risk of becoming mixed and misrepresented? Every one who has been connected with work of this kind realizes the difficulty in establishing an efficient connecting-link between the plant-breeder and commercial interests, and in the careful multiplication and distribution of new strains. For this purpose no better means could be devised than certification. Here, then, is one aspect justifying State expenditure in certification so that the country may reap the benefit of past expenditure involved in the slow and costly process of creating new varieties.

Finally, we should give consideration to the possibility of seed certification replacing, partly if not wholly, seed legislation, the enforcement of which would entail considerable State expenditure.

Conclusion.

This brief review has of necessity indicated only certain of the high lights of certification. As to the future, one is hopeful of very great expansion, but it seems desirable to sound a note of warning that this expansion should never be at the expense of quality. Seed-merchants everywhere are keen to catalogue something new, something that will attract attention, and in certified seed they have an excellent opportunity. Nevertheless, these same merchants will not continue to handle certified seeds except their clients demand it. And their clients will not create this demand unless they receive every satisfaction. Not sudden notoriety, but consistent quality, should be our goal, and we must guard very jealously the standard of our certified products.

The writer has been associated with seed certification since its inception in New Zealand, and would like to record here his appreciation of co-operation afforded by all who have been connected with the work. No organization can be devised which is proof against roguery and trickery, yet since its inception there has not been a case of wilful misrepresentation. All realize the necessity for strict honesty and care, and this attitude of mutual trust has been of material help in making the service pleasant as well as useful.

Effective Control of Fireblight on Pear Trees.—The following experience is reported by Mr. M. Talbot, Fruit Inspector, Auckland: "For the last four years a small orchard of Williams Bon Chretien pears at Whangarei has been badly infected with fireblight, both blossom and twig infection. Last year there was a very heavy blossoming, and the trees suffered badly with blossom infection, which was properly treated, all infected parts being cut out and burned. This season there was also a heavy blossoming, but with a good set of fruit and no sign of blossom or twig infection. Several other orchards in this district have had the same experience."

COMMERCIAL FERTILIZERS AND THEIR BASIS OF SALE.

VII. THE CHOICE AND PURCHASE OF FERTILIZERS.

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IN previous articles of this series special consideration was given to the individual fertilizer types on the market. This concluding article, however, deals more particularly with their choice, valuation, and purchase, and at the same time sums up some of the more important features connected with their sale. Regarding the methods of evaluating fertilizers referred to in these pages, it should, of course, be clearly recognized that there is need for care and discrimination when comparing two fertilizers of a different character but with similar plant-food constituents. Manufacturing costs, too, vary greatly with the different classes of fertilizer, as also do the length of time and extent to which fertilizer ingredients become available in the soil. Further to this, the fertilizing-value may at times vary considerably in different parts and parcels of the same material. However, if judgment is used, the estimation of commercial or unit values under special circumstances can undoubtedly be of assistance in making a choice from the very large assortment of fertilizers of merit available.

A KNOWLEDGE OF FERTILIZERS ESSENTIAL.

Progress is continually being made in the science of plant nutrition, and present economic conditions certainly do indicate that fertilizer manufacturers and consumers alike should be on the alert to the adoption of new ideas, developments, and improvements in fertilizer manufacture, distribution, &c., promoted in other countries. Serious consideration must be given more and more to the question of accurate methods of feeding plants. Further attention must also be paid to the physical and chemical effects of fertilizers in the soil, and to their effects not only on crop quality but on the conditions of marketed products, farm animals, and even on mankind.

Every year this country, in common with many more agricultural countries, spends considerable sums of money on fertilizers and associated materials, such as lime, in order to improve the quality and production of pastures and crops. Out of the very large number who use these commodities only a small proportion have a really sound knowledge of what they are handling. The great majority are still not properly conversant with the facts bearing on these vital materials and their place in plant-feeding or soil improvement; nor are they well acquainted with the various terms used in the fertilizer trade, which truly has a language peculiarly its own. A sound knowledge of the real composition of fertilizers and limes on the market is one of the first requirements for all sellers and buyers to-day. Without such knowledge, for instance, evidence deduced from the behaviour of such materials in field trials may be quite erroneous or worthless. The rate of application per acre, too, is governed by their chemical composition.

It is not necessary, of course, for the user to have a complete technical knowledge, nor is there any great need for him to have a knowledge of chemistry; but he should at least have some working or fundamental knowledge which will enable him to buy prudently to suit to the best possible economic advantage his conditions on the farm. With such a knowledge he need not be confused by the numerous trade leaflets, circulars, and advertisements issued by some vendors.

No doubt the problem of the consumer is always a difficult one, but there are certain facts which ought to be considered before purchase of fertilizers is undertaken, and one of the most important is to ascertain first of all whether the land requires treatment and what type or combination of fertilizers is best suited to the farming system adopted. Users of fertilizers have much to gain by keeping in touch with those who have experimented accurately over long periods with fertilizers on different crops and soils. The help of the district agricultural instructor, inspector, or adviser is available in such matters. Intelligent and accurate experimentation under the guidance of these officers is of the greatest value on an individual farm or field. Apart from this, however, the farmer is often obliged to study his own soil, pastures, and cropping conditions, and to experiment for himself, for when it comes to the question of the profitable use of fertilizers each farm and field must answer for itself. Quite often a portion of the farm may be growing poor crops, not so much through the lack of essential plant-food but through many other factors such as the lack of water, humus, or adequate drainage, or through unsuitable climatic conditions, poor seed or strain of plants, and so on. As an illustration, in a very dry climate an insoluble form of phosphate or nitrogen may be of no value, notwithstanding a deficiency of these elements in the soil.

If the farmer is quite satisfied from the result of accurate observation or actual trial that his land does require supplementary plant-food, he should always remember that the lowest-priced fertilizer is not always the best value, and that fertilizers are not a cure-all. In conjunction with thorough cultivation, liming, rotation, the ploughing-in of green crops where necessary, and other sound soil improvement or management practices, they are of the greatest assistance when suitably applied in the right proportion.

A Few Words for the Fertilizer Salesman.

In the earlier days of the commercial fertilizer trade the salesmen were often very poorly informed on matters relating to agriculture and fertilizer technique. For the most part they were order-takers and did not understand, nor were they expected to understand, the products they were selling. The tendency was to sell so many tons of fertilizer and not plant-food. This tendency is still apparent to-day, and it is not unusual for the salesman who sells merely tons to be put into an embarrassing position by a well-informed purchaser. In these days the consumer is entitled to know why a certain class of fertilizer recommended by the salesman will produce good effects under his particular soil and plant conditions. There is no doubt, too, that the knowledge of the man on the land is increasing all the time, so that it becomes the immediate duty of the fertilizer manufacturer or merchant to ensure that his salesmen, who are in direct contact with the farmer—probably more than any one else—are thoroughly conversant with the products

they are handling, otherwise any recommendations they may make may be quite unreliable. In the fertilizer trade, whether engaged in the manufacturing, selling, or accounting branches, all will find the possession of a small fund of chemical facts or a superficial knowledge of chemistry and a rudimentary understanding of the principles of agriculture of considerable assistance in the discharge of their duties.

A well-informed salesman or business manager in a fertilizer firm should know at least something of the following as a basis for making sound recommendations to clients :—

(1) The main soil types and their characteristics and the results obtained from any official field experiments conducted in his particular district or districts where sales are made.

(2) The adaptability and management of these soils to general or special crops.

(3) The general crop requirements for fertilizer and the generally known effects of the latter on crop quality.

(4) Some facts relating to the pathology and physiology of plants.

(5) The more common fertilizer and lime materials, and the behaviour of the essential fertilizer ingredients—phosphoric acid, nitrogen, and potash. Also some recognition of the part played by other plant nutritional elements such as iron, sulphur, iodine, &c., under special conditions for promoting plant growth and profitable production.

(6) The values, costs of mixing, cartage, and distribution of fertilizers.

He should further be well acquainted with the main provisions of the Fertilizers Act and its regulations, which set forth specifically the conditions under which fertilizers may be sold. He should recognize that such a law is necessary to prevent chaotic conditions that might easily creep into the fertilizer trade to the detriment alike of the consumer, manufacturer, and vendor.

Some knowledge of insecticides, fungicides, &c., and the control of diseases and pests is useful, while some acquaintance with the management of pastures and crops, the ploughing-in of green crops, and the use of stock-foods, mineral licks, and remedies is of great assistance.

With the great amount of accumulated information that is now available, there is no need for fertilizers to be either bought or sold in a blind fashion. At the same time, farmers and salesmen should also mutually benefit from an interchange of knowledge and ideas on fertilizers whenever an opportunity occurs for a discussion of this nature.

Choice of Fertilizers.

The value of any fertilizer depends primarily on the amount of plant-food that it contains, but it must not be forgotten that nitrogen, phosphoric acid, and potash may exist in a variety of forms differing widely in efficiency and rate of action. It is quite possible for a fertilizer containing fairly high percentages of one or more of these plant-foods to be worth really very little owing to the extreme slowness with which they become available to crops. Coarsely ground rock phosphate or badly prepared bone-meal are cases in point.

The New Zealand Fertilizers Act provides that the seller must supply the buyer with an invoice certificate in which it is clearly stated the percentages of the customary plant-foods—nitrogen, phosphoric acid, and potash—contained in any fertilizer offered for sale. Delivery of fertilizer should not be accepted unless the accompanying invoice certificate states the respective amounts of these ingredients in the proper manner. Unfortunately, however, the law does not preclude the use of confusing or misleading descriptions in price-lists, circulars, and advertisements. Even the bags sometimes carry statements which are apt to confuse or mislead prospective purchasers. A custom giving rise to a good deal of confusion is the one under which nitrogen is expressed in price-lists and trade propaganda as ammonia, phosphoric acid as phosphates, and potash (K_2O) as sulphate of potash. This practice serves no useful purpose and often induces the buyer to take a material unsuited to his particular purpose in view, or it may be a lower grade than he intended to purchase; in addition, he is very much perplexed when a signed statement of analysis set out in the standard manner is received on delivery of the goods. (See pages 205 and 206 for standard method of statement of plant-food composition of fertilizers.)

The purpose of ordering fertilizer is to get something which will give increased production and/or improved quality of crops for the lowest possible expenditure. The temptation to any one buying is often to take one of the low-grade materials (for example, kainit, in preference to 30-per-cent. potash salts or high-grade muriate of potash), as a comparatively large bulk is obtained for the money spent in the case of the former. This policy of buying fertilizers at so much per ton is not a good one. If purchases are made on the basis of their plant-food and their solubility and other features, and not so much on the price per ton, the farmer would be saved much expense in the transport, handling, and distribution of a considerable amount of inert or unnecessary substance contained in many of the lower-quality goods, and which merely adds to the weight. In cases of doubt, he should first of all compare, where possible, the values of fertilizers on the basis of the costs per unit of plant-food, a method of valuation briefly outlined farther on in these pages. The fertilizer with the lowest unit value, having regard to other features such as solubility and suitability for the soil and crop under view, is usually the more economical.

It is necessary, nevertheless, to draw especial attention to the fact that fertilizers in certain cases should not be bought solely on account of their cheapness per unit; it is essential that they should be suitable for the particular soil and crop. On light soils deficient in organic matter it may be found desirable to use organic manures such as stable or cow manure, blood and bone, fish-meal, &c., or to plough in some green crop like blue lupins in order to increase the soil organic matter, thereby supplying a store of plant-food and improving the water-holding capacity of the soil. In another case it may happen that nitrogen can be bought more cheaply per unit in sulphate of ammonia than in nitrate of soda, calnitro, or cyanamide. However, if the soil is deficient in lime compounds, it would probably be better to use one of the three latter products in preference to the former unless lime is to be had at a cheap rate from a near source for separate application.

Other factors influencing the effectiveness of fertilizers are the degree of fineness and general mechanical condition of the material. If fertilizers, more especially those of an insoluble nature like rock phosphate, basic slag, bone-dust, blood and bone, fish-meal, &c., are not ground to a requisite degree of fineness in each respective case, their efficiency as plant-food suppliers may be seriously handicapped. As regards rock phosphates and basic slags, at least 80 per cent. of the material when in the ground state must, according to the law, pass through a sieve containing 10,000 holes to the square inch. Again, where the mechanical condition of the product is poor, there is always the difficulty of distribution on the land. Mention may also be made of the moisture-content, which if excessive is the cause of lumping, and in putting the material through the distributing machine unsatisfactory application is unavoidable. If the material contains moisture—say, 25 per cent.—in excess of what is normal the farmer has to pay for cartage of this excess. Deterioration in storage is another factor which influences the purchase of fertilizers.

Before making a choice, especially for the first time, it is a good plan to (1) decide what fertilizers of each class (phosphatic, nitrogenous, or potassic) are suitable for the crop in view, (2) obtain quotations from several firms for these fertilizers, and (3) calculate the unit values of nitrogen, phosphoric acid, and potash as the case may be. It is quite evident that in the economical purchase of fertilizers it is necessary to have a fairly exact knowledge of the kind of fertilizer needed for the crop in question, and it is here that the advice of an instructor or adviser comes in useful. Nearly every merchant's or manufacturer's catalogue will show mixtures listed as being suitable for pasture, turnip, rape, mangels, grain, fruit-trees, &c. Such mixtures, however, can represent only a certain average adaptability, and cannot take into account either the particular class of land on individual fields or farms or the condition they have been left in by previous cropping. Moreover, a great number of the mixtures offered for sale in New Zealand as suitable for a variety of crops of widely divergent nutritional requirements differ but slightly in fertilizing-value. Mixtures containing less than 2 per cent. of nitrogen and 2 to 3 per cent. of potash, with a good measure of about 18 to 20 per cent. of phosphoric acid, are often wrongly given such names as "nitrogenous top-dressing" or "potash top-dressing," and so on. Certainly they do contain nitrogen or potash, but the proportion is so low as to be hardly worth the mixing in.

The farmer who has the necessary knowledge to manure according to the special requirements of his own land often mixes his own fertilizers or sows them separately. Other farmers by paying a little extra to the merchant or manufacturer can have a well-thought-out mixture made up in consultation. As a general rule it is far better to have the mixing done by the fertilizer manufacturers or merchants, as they have the necessary apparatus to ensure the production of a well-conditioned or blended fertilizer of even composition; further, as already indicated, they have in some cases specialists who are in a position to give unbiased information on the suitability of certain mixtures for particular soil conditions and crops. For the consideration of any farmers who do prefer to do their own mixing it is proposed to publish a special article on the subject in this *Journal* later in the year.

Influence of Fertilizers on Crop Quality.

A knowledge of the effects of modern fertilizers on crop quality and the separate functions of each plant-food, as far as relatively limited observations and research indicate, is now recognized as being of paramount importance in the choosing of fertilizers generally. The following information dealing for the greater part with the effects of the three principal fertilizer ingredients on plants and plant-products is to some extent based upon an excellent comprehensive review of the world's fertilizer literature—"The Influence of Fertilizers on Crop Quality" (Dec., 1932)"—compiled by Dr. B. L. Hartwell under direction of the National Fertilizer Association (U.S.A.), and with the co-operation of the Committee on Fertilizers of the American Society of Agronomy.

Nitrogen.—The major effect of the plant-food nitrogen is to increase the quantity of protein in a crop and thus enhance its quality, although if supplied in excessive quantities it may have the reverse effect. Most modern nitrogenous fertilizers are soluble in the soil, and the plant may absorb nitrogen to such an extent that too much protein in proportion to other matter is produced in it, with a consequent detrimental effect on its quality. For example, in crops which depend on a high content of non-nitrogenous constituents as a measure of quality, an increase of protein may decrease these compounds and cause a lowering of quality. Outstanding deleterious crop influences of an excess of nitrogen are observed in sap impurity in sugar plants; lodging and immaturity; quality of fibre crops; red fire, and smoking quality of tobacco; and keeping quality, colour, and odour of hops. Still greater amounts will cause burning of crops. The effects of an excessive supply of nitrogen in the soil may, however, be largely offset by the addition of appropriate amounts of phosphatic and potassic fertilizers to ensure a better balance in the crop's food-supply. If there is a deficiency of nitrogen the foliage of the crop will appear light green, instead of a darker healthy colour.

Plants take up nitrogen chiefly in the form of nitrates, so that nitrates of soda, lime, ammonia, &c., can be utilized by crops at once; and on account of their certain and rapid action, these forms, if properly used, very often give the greatest return in weight of crop for a given quantity of nitrogen supplied. The nitrogen of other well-known manures such as dried blood, cyanamide, and sulphate of ammonia, is not as a rule taken up by plants directly, but is first changed by the action of soil bacteria to the nitrate condition. This makes such manures somewhat slower in action than the nitrates, and while for certain crops this is a distinct advantage, there is always a certain amount of loss in the process of change to nitrates. If properly used, more nitrogen is recovered in a crop when a quick-acting manure is supplied than when a slow-acting one is used.

Phosphoric Acid.—The protein-content of plants, even of non-phosphorus proteins, is also increased by phosphoric acid, but its beneficial effects on the promotion of carbohydrates is more pronounced. Certain vitamins in wheat are also favourably influenced by the presence in the soil of an available supply of phosphoric acid, which also has the effect of generally increasing the strength of plants and of producing fruit of better condition. As a hastener of maturity phosphoric acid is outstanding, and undoubtedly increases the keeping

quality of fruits. When absorbed with nitrogen it offsets the maturity-retarding influences. Plants well fed with phosphates are also likely to be more resistant to fungoid and insect attacks. Owing to the fact that it so readily forms insoluble compounds in the soil, phosphoric acid is not likely to be absorbed by plants in quantities deleterious to their growth.

Phosphates may be divided broadly into two classes—those which are soluble and those which are insoluble in water. The different forms of soluble phosphates are very similar in action and value, but there is considerable variation in crop response to the various forms of insoluble phosphates. These latter may all be insoluble in water, but to varying extents become soluble in the dilute soil-acids. An arbitrary method often adopted by agricultural chemists for an approximate comparison of their solubility in the soil is to find what proportion is soluble in a weak solution of citric acid* in a given time. This " citric-soluble " phosphoric acid must not, however, be confused with the water-soluble phosphoric acid of superphosphate and concentrated fertilizers such as mono-ammonium phosphate, di-ammonium phosphate (Diammonphos), Nitrophoska, Leunaphos, &c. The main difference lies in the greater rapidity of action of the latter class, which is due to the plant-food being more quickly distributed through the soil. It seems to be an accepted fact that phosphates, such as the dicalcium or tetra-calcium form, soluble in citric acid have more immediate fertilizing-value in most soils than phosphates (tricalcic) insoluble in water and soluble only to a very limited extent in citric acid. Therefore, in evaluating the phosphoric acid in basic slag and, say, certain mixed manures containing dicalcium phosphate, it is sometimes considered desirable to ascertain the proportion of water-insoluble phosphoric acid that is soluble in the standard citric-acid solution.

Potash is applied to plants in soluble forms, usually as chloride or sulphate of potash. It seems to be necessary in the initial stages of plant growth for helping in the building-up of protein, and appears to offset to some extent the deleterious effects of excessive nitrogen. Its outstanding influence, however, is in stimulating the formation of the non-nitrogenous constituents of plants—*e.g.*, starch, sugar, and other carbohydrates. It has a tonic effect on the general condition of crops, and reduces their susceptibility to a number of troubles—for example, discoloration of potatoes and leaf-scorch of fruit-trees. Potash is also reported to improve the cooking quality of potatoes where mealiness is desired, and tobacco acquires a better smoking quality if potash fertilizers in forms other than the chloride are supplied to the soil in sufficient quantity. The property of potash of promoting the formation of all carbohydrates enhances the quality of fibre plants and strengthens the tissues which prevent lodging. Like phosphoric acid, potash improves the keeping quality of fruit and vegetables; it also has the additional advantage of increasing the size of kernels, whereas phosphoric acid may merely increase their number.

* Recent experiments in Great Britain undertaken with the object of finding a more satisfactory method of comparing the availability of phosphoric acid in basic slag, by chemical means in correlation with field trials, seem to indicate that a method of indicating solubility by extraction with a solution of sodium chloride gives more uniform results with slag.

Although nitrogen, phosphorus, and potassium are the elements commonly deficient in soils, other accessory elements, such as magnesium, manganese, sulphur, sodium, iron, &c., also have a relatively important bearing on the quality of various crops. Magnesium specifically improves the ash of smoking-tobacco. Sodium, although not an essential element, may be useful when plants are suffering from an insufficiency of potassium.

Purchase of Fertilizers.

Having decided on the class of fertilizer required, the buyer may often save on his fertilizer bill by selecting the most economical form of plant-food carrier by an intelligent use of the unit-valuation method. This system is applied principally to straight fertilizers (*i.e.*, materials containing only one essential plant-food), the unit value being easily determined by dividing the price per ton of the particular fertilizer by the percentage of plant-food it contains. The resultant figure is the value of 1 per cent. or one unit of plant-food.

The commercial or trade values of fertilizers, it should be borne in mind, have no relation to their agricultural values. Trade values are determined by the law of supply and demand, and many materials used in fertilizers are required by other industries, so it is not entirely the agricultural demand that sets the price. The agricultural value of a fertilizer is determined by the value of the increase in crop-production obtained from its use, and is dependent upon many factors. It is often the case under special circumstances for a fertilizer of poor value commercially to have a high agricultural value.

Although the method of estimating unit values has been briefly referred to before more than once in this series of articles (and by other writers in this *Journal*), the following examples are given to illustrate the method of calculating and comparing the unit value of various phosphatic fertilizers containing only one plant-food :—

(1) Superphosphate containing 20·1 per cent. or units of water-soluble phosphoric acid is quoted at £4 per ton.* The unit value of water-soluble phosphoric acid is therefore 80s. ÷ 20·1, or approximately 4s. per unit. Superphosphate, strictly speaking, is comparable only with other fertilizers containing water-soluble phosphate, such as double superphosphate, ammonium phosphate, &c. Different grades of superphosphate and the price quotations of this fertilizer from different sources and in various mixtures may be compared on the basis of this system of valuation.

(2) A ground rock phosphate containing 33·4 per cent. of phosphoric acid insoluble in water is quoted at £3 17s. 6d. per ton. The value of insoluble phosphoric acid may therefore be taken as 77½s. ÷ 33·4, or approximately 2s. 4d. per unit. Ground rock phosphate is comparable with other insoluble forms of phosphate, and the values of rock phosphate of any grade from different sources and in various mixtures may be determined and compared.

* As the present Government subsidy on superphosphate does not operate for this material contained in mixtures, the price for superphosphate in such mixtures is charged at about £4 15s. per ton, giving a unit value of 95s. ÷ 20·1 = 4s. 9d., and this latter price should be used when comparing the value of mixed fertilizers containing water-soluble phosphoric acid.

(3) Basic slag containing 17 per cent. of total and 13·6 per cent. of citric-soluble phosphoric acid is quoted at £5 5s. per ton. (*a*) The unit value of insoluble phosphoric acid in basic slag, therefore, is 105s. ÷ 17, or approximately 6s. 2d. per unit, a considerably higher figure than two or three years ago, when supplies were more plentiful and the exchange-rate lower. By this means the unit values of various grades of basic slag may be compared and the most economical one chosen. When comparing different brands, however, notice should be taken of the fineness of grinding, which should not be less than 80 per cent. (*b*) If it is desired to find the value of the citric-soluble phosphoric acid only in basic slag, the amount of phosphoric acid insoluble in citric acid must first be valued at the price of insoluble phosphate. In the example quoted, 17 less 13·6 or 3·4 per cent. of the phosphoric acid is insoluble in water and citric acid. The value of this, then, is 3·4 × 2s. 4d., or 7s. 11d. Therefore the value of 13·6 units of citric-soluble phosphoric acid is £5 5s. less 7s. 11d., or £4 17s. 1d., and the value of one unit of citric-soluble phosphoric acid, 97s. 1d. ÷ 13·6, or 7s. 1½d. per unit.

(4) Bonedust quoted at £9 5s., and which contains 3·7 per cent. nitrogen and 24 per cent. phosphoric acid per ton, has a unit value of 4s. 7½d. for phosphoric acid, allowing an arbitrary value of £1 for each 1 per cent. of organic nitrogen.

With the different classes of phosphate it is generally agreed that insoluble forms are of less agricultural value than the soluble forms, except where special soil and crop considerations are to be taken into account. It is also recognized that bonedust, as a result of having organic matter in its make-up and a small nitrogen-content, is superior to ground rock phosphate. In the case of basic slag its high liming-value is an asset in areas of high rainfall where lime as well as phosphate may be required for the soil. The same would apply in the case of ground rock phosphate and soft earthy phosphates with appreciably high free lime content. According to British authorities it would appear that each ton of high-grade basic slag has a combined liming-value equivalent to about one ton of good-quality ground limestone, in addition to its usefulness as a phosphatic fertilizer. Its content of iron and other nutritional elements of unrated market value may also be of advantage under special circumstances.

By means of the simple system which has been briefly outlined unit values may be obtained for soluble nitrogen (N) in sulphate of ammonia, nitrate of soda, and insoluble nitrogen in dried blood, cyanamide, &c.; and for potash (K_2O) in sulphate or muriate of potash, kainit, potash salts, &c. (See pages 146 and 326 in September and December, 1932, issues respectively of this *Journal*.) In the valuation of potassic fertilizers it is generally assumed that soluble potash has about the same agricultural value in whatever form it occurs, provided that special crop considerations are taken into account. The cheapest form of potash per unit is usually the most economical, due allowance being made for transport costs, &c.

If it is desired to find what may be termed an arbitrary unit value of, say, phosphoric acid in certain other fertilizers which also contain either nitrogen or potash or both, it is necessary to deduct the value of the latter two from the price of the fertilizer, using the unit values

calculated from price-lists of the corresponding straight fertilizers—for example, sulphate of ammonia (water-soluble nitrogen) or dried blood (insoluble nitrogen); and in the case of potash, sulphate or chloride of potash (for example, potash salts). The unit value of the remaining plant-food (phosphoric acid) may then be determined by dividing the price obtained by the percentage (the number of units) of phosphoric acid in the fertilizer. This method is used in arriving at an approximate estimation of the value of mixed fertilizers, blood and bone, concentrated complete fertilizers, &c.

An example of how to evaluate Nitrophoska, a highly concentrated article, which was quoted some time ago at £18 15s. per ton at Auckland, follows to illustrate the method outlined:—

Table 1.—Evaluation of Nitrophoska.

Plant-food.	Percentage in Fertilizer.	Price per Unit.	Estimated Value per Ton of Fertilizer.
		s. d.	£ s. d.
Nitrogen (soluble in water)	16·5	10 5	8 11 10
Phosphoric acid (soluble in water) ..	15·2	4 10	3 13 6
Phosphoric acid (soluble in citric acid)*	1·3	5 3	0 6 10
Potash (soluble in water) as chloride ..	20·0	4 11	4 18 4
Total	..	..	17 10 6
Price quoted	..	..	18 15 0
Difference	..	..	1 4 6

* Citric-soluble phosphate is usually included in the statements of water-insoluble phosphoric acid, and where some of this latter is soluble in citric acid due allowance must be made for it when calculating the value of the insoluble phosphate by first subtracting it from the percentage insoluble in water.

It would appear from the above estimate that this fertilizer was rather too expensive under the then ruling prices, and that unless very heavy transport charges were to be incurred it would have been more economical to have bought corresponding quantities of sulphate of ammonia, superphosphate, and potash salts. It should be borne in mind, however, that in buying high-grade concentrated fertilizers a considerable reduction in bulk may be effected, and consequently that a substantial lowering of transport costs may be made possible. For example, one bag of, say, urea, containing 46 per cent. of nitrogen soluble in water, will supply the same amount of nitrogen plant-food as 2½ bags of sulphate of ammonia or over three bags of nitrate of soda. This question is treated in the next section.

How Transport Charges Influence the Cost of Plant-food.

The cost per unit of plant-food is of primary importance, but where charges for carriage to the farm are high, such costs must be taken into consideration. This is a matter of considerable importance to those whose farms are in outlying districts, and when considering the purchase of fertilizer they should think of the *number of tons of plant-food* and *not* the *number of tons of fertilizing material* required to top-dress their land.

It may happen that to supply a certain quantity of plant-food 20 tons of one particular fertilizer may be required to give the same

amount of plant-food as 30 tons of a lower-priced and lower quality article, even though the latter at first sight may appear to be cheaper per unit. On the one hand transport costs would have to be paid on 30 tons, while on the other hand these charges would be incurred on only 20 tons of the higher-grade material. In cases of this type all extra charges for carriage of the fertilizer to the farm must be added to the price quoted for the whole consignment, and the resultant figure divided by the number of tons in the consignment. This will give the actual cost of each ton of fertilizer delivered on the farm. On the basis of this latter price the unit values of the fertilizer to be selected should be calculated, the one giving the lower unit value being, of course, the more economical.

List of Classified Typical Commercial Fertilizers and Fertilizer Materials handled in New Zealand.

Table 2.

Fertilizer Material.	Plant-food Content (Average).				
	Nitrogen (N).		Phosphoric Acid (P_2O_5).		Potash (K_2O).
	Soluble in Water.	Insoluble in Water.	Soluble in Water.	Insoluble in Water.	Soluble in Water.
Phosphatic Fertilizers.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Superphosphate, 22–23%	..	..	22·0	..	..
Superphosphate, 20–21%	..	..	20·1	..	..
Superphosphate, 19–20%	..	..	19·2	..	..
Superphosphate, 16–17%	..	..	16·5	..	..
Basic superphosphate	..	..	..	19·0	..
Superphosphate and lime (1 : 1)	..	..	..	10·0	..
Superphosphate and lime (2 : 1)	..	..	..	14·0	..
Superphosphate 20–21% and Seychelles phosphate	..	..	8·0	15·0	..
Basic slag, 20–22%	..	..	..	20·0	..
Basic slag, 18–20%	..	..	..	18·0	..
Basic slag, 17–20%	..	..	..	17·0	..
Basic slag, 15%	..	..	..	15·0	..
Ground Rock Phosphates.					
Nauru-Ocean Islands, 36–38%	..	..	..	36·5	..
Moroccan, 33–36%	..	..	..	34·0	..
Tunisian* 26–27%	..	..	..	26–27	..
Tunisian* 27–28%	..	..	..	27–28	..
Tunisian* 29–30%	..	..	..	29–30	..
Tunisian* 30–31%	..	..	..	30–31	..
Egyptian : Ephos	..	..	..	25·0	..
Phosphatic Guanos (soft natural phosphates, screened but not submitted to a grinding-mill like rock phosphates)—					
Seychelles Islands (Assumption, Dennis, St. Pierre, and Juan de Nova)	..	..	..	26·5	..
Walpole Island	..	..	..	19·8–20·7	..
Phospho-Nitrogenous Fertilizers.					
Ammoniated superphosphate	6–6·5	..	..	11–14	..
Basic ammoniated superphosphate	2·8	..	..	12·2	..
Nitro-superphosphate	1·3	..	17·1	..	..

* Sold under such names as Solfos, Phosfull, Hyfos, Gafsa, &c.

Table 2—continued.

Fertilizer Material.	Plant-food Content (Average).				
	(Nitrogen (N).		Phosphoric Acid (P_2O_5).		Potash (K_2O).
	Soluble in Water.	Insoluble in Water.	Soluble in Water.	Insoluble in Water.	Soluble in Water.
Phospho-Nitrogenous Fertilizers—continued.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Bonemeal or bonedust	..	2·3–4·3	..	17·2–27·2	..
Blood and bone	..	4·7–8·5	..	8·2–21·9	..
Meat and bone (tankage)	..	7·3	..	11·5	..
Bone tankage	..	8·0	..	10·0	..
Whalebone meal	..	2·9	..	22·5	..
Fish fertilizer	..	5·8	..	12·8	..
Leunaphos (concentrated fertilizer)	20·0	..	20·0	..	..
Diammonium phosphate (concentrated fertilizer)	20·6	..	52·5	..	..
Nitrogenous Fertilizers.					
Sulphate of ammonia	20·6	..	..	..	..
Nitrate of soda	15·0	..	..	..	..
Urea (concentrated fertilizer)	46·0	..	..	..	..
Calnitro (nitrate of ammonia and lime)	20·5	..	..	..	..
Calcium cyanamide	..	20–22	..	..	..
Dried blood	..	12–14	..	..	..
Potassic Fertilizers.					
Sulphate of potash (concentrated fertilizer)	..	..	..	..	48·6
Muriate of potash („ „)	..	..	..	..	50·4
Potash manure salts, 30%	..	..	..	..	30·0
Potash manure salts, 20%	..	..	..	..	20·0
Kainit, 14%	..	..	..	..	14·0
Phospho-potassic Fertilizers.*					
Potassic superphosphate	..	..	16·5 19·0	..	3·0 2·3
Potassic basic superphosphate	..	..	..	17·2	2·2
Potassic mineral (rock) phosphate—					
Potassic phosphate	..	..	..	27·5	5·0
Potassic Phosfull	..	..	..	23·0	5·0
Potassic Gafsa	..	..	..	18·0	8·0
Phospho-nitro-potassic Fertilizers.					
Nitrophoska (concentrated fertilizer)	(*a*)16·5 (*b*)15·5	..	15·2 14·2	1·3 1·3	20·0 19·0
Enpekay (concentrated fertilizer)	12·5	..	12·5	..	15·0
Nitro-potassic phosphate	..	3·5	..	15·0	4·5
Dissolved Peruvian guano	..	4·5	..	9·0	1·5
Peruvian seabird nitrogenous guano and potash	..	5·7	..	11·4	6·0
Average plant-food content of local proprietary factory-mixed fertilizers containing proportions of the three essentials	1·3		18·5		2·0

* Well-known phosphates to which potash either as sulphate or chloride is added.

Acknowledgments.

In connection with this series of articles, which was originally intended to be devoted to a discussion of only a few of the main fertilizer types on the market, the writer is indebted to Mr. B. C.

Aston and Mr. R. E. R. Grimmett for various suggestions; also to Mr. K. F. Hoy for assistance in the preparation of tables, &c.

The writer also wishes to express his great indebtedness to very many sources of information in New Zealand and elsewhere. A full set of references would be too lengthy to set out here, but mention may be made of a number of informative works which would be helpful to readers or students wishing to acquire a wider knowledge of fertilizers and plant-feeding, also of the fertilizer industry. This short bibliography is as follows:—

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PRODUCTION OF DISEASE-FREE SWEDE SEED.

PRELIMINARY TRIALS UNDER THE SMALL-FARM PLAN.

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THE swede provides the most valuable fodder crop in New Zealand. It does well almost everywhere, from the light pumice soils of Auckland Province to the heavy clays of Southland. On mixed farms it is an essential crop in a balanced rotation, and on ploughable hill country it is unrivalled as a provider of winter feed. The full utilization and maintenance of pasture depends on an adequate supply of stock to cope with the spring growth, and swedes provide one of the best and cheapest fodders to carry that stock over the lean winter months.

The swede is thus of great national importance in maintaining the average stock-carrying capacity of the Dominion. Of recent years, however, the area sown to swedes has steadily declined, and this for one reason only—the fear of disease. The two diseases of swedes—dry-rot and club-root—have become so widespread in incidence and so destructive in effect that the swede has become a risky and often unprofitable crop, to be replaced where possible by other less satisfactory but more certain fodders. Owing to disease it is no longer safe to grow more than one crop of swedes in several years on any piece of land, and the continual breaking up of established pasture, even where sufficient ploughable land is available, makes the cost and inconvenience of the crop more than it is worth.

Investigations into the problem of these two diseases, extending over many years, have now brought certain facts to light:—

(1) Dry-rot infection is carried in the seed. If seed free from the disease is sown on land that has not carried a diseased crop for the past

two seasons, nor is in the neighbourhood of swedes or turnips grown from infected seed, then the resultant crop will remain free from dry-rot.

(2) Club-root can be practically controlled by the use of certain varieties or strains of swede which are highly resistant to the disease, if certain precautions are taken in the sowing.

It is therefore of great importance that adequate supplies of guaranteed dry-rot-free seed of club-root-resistant strains should be available to the farmers of New Zealand. The following pages detail the methods and outline a plan by which it is proposed to attain this end.

Methods of Production.

Experimental work has been in progress for the last four years at the Plant Research Station on the best methods for the production of high-quality disease-free swede seed. Much of this work has been based on information secured by the Mycologist in the course of a thorough personal investigation of the methods in use in Great Britain and on the Continent of Europe.

The swede is a biennial plant which, whether sown in the spring or in autumn, will flower and seed in the following summer. If spring sown it will produce a large bulb with no lateral roots, that, if not attacked by disease, will keep through the winter to send up a flowering stalk in the spring. If autumn sown it produces little or no bulb but well-developed lateral roots, and in the spring bolts strongly to seed. The seed head produced by the large bulb from spring sowing draws its nourishment from the stored food material in the bulb, little or no fresh root development taking place. As a consequence the flowering head, though developing strongly at first while food and moisture are plentiful, becomes weaker as development proceeds, until, while the seed is forming, most of the stored food material is used up and many of the later seed-pods fail to develop. The result is a light crop of undersized seed. Moreover, the bulbs are very liable to attack by various rot-forming fungi and bacteria before the seed has filled. It is thus not practicable to produce seed commercially by this method, which is used only for the growing of mother seed—that is, seed to be sown in the autumn for the production of the next year's commercial crop. This is necessary since selection for type and quality can only be done when the plants are grown to full maturity under the best conditions for bulb-development.

The main seed crop, then, is produced from plants grown from mother seed sown in the autumn. This may be sown in place and the resultant plants thinned to about 18 in., but experiments have shown that a better result is obtained by raising the seedlings in special nurse-beds and transplanting to the final position for seeding. In the mild winter climate of Palmerston North swedes if left undisturbed continue to grow, and will produce quite fair-sized bulbs even when late autumn sown. These bulb-forming plants do not make such strong feeder-root development in the spring as do plants which have been checked by transplantation.

It is commonly supposed that seed produced in this manner will tend to produce "bolters" when sown for an ordinary crop. There is no evidence to support this supposition, but much to the contrary. Most, if not all, the swede seed of commerce is so produced. Good

well-drained soil is essential for this crop. If broken out of the lea the turf should be skim ploughed in January or February, disked and harrowed at intervals till May or June, then deeply ploughed and thoroughly worked down ready for planting out in late June and July. The plants should have plenty of room to develop, a very suitable spacing being 18 in. in 4-ft. rows. Cultivation should be thorough and continuous as long as it is possible to work between the rows.

The primary flower-stalk is topped at about 18 in., in order to promote strong lateral branching. Experience has shown that the whole object should be to produce a vigorous plant with strong branching systems both of the root and head. Such a plant will pod heavily to produce the maximum weight of plump evenly ripening seed. Harvesting is done by hand with a sickle, the plants being immediately tied in small bundles. These are laid in windrows and carefully turned from time to time. At Palmerston North it has been found that the drying process takes about three weeks to allow time for the greener pods to ripen off. It would probably be advantageous to then stack for two or three months before threshing, but quite a satisfactory sample has been obtained by threshing in the paddock.

The threshing is done by hand flails on a large canvas sheet, cleaning being effected by riddles and a final wind winnowing. Not more than 100 lb. to 150 lb. of seed should be placed in each sack, and the sacks stacked to allow for the maximum ventilation. If the cleaning is carefully performed this seed is quite fit for sowing, but, to produce the best looking sample, it may be machine dressed in a properly equipped mill. This operation will separate out any remaining rubbish and also the " seconds " or smaller seed, which, though usually showing quite as good germination as the " firsts," detracts from the even appearance of the sample. A danger that must be guarded against at all costs in mill-cleaning is the admixture of seed left over in crannies in the machinery from previously dressed lines that may have been infected with dry-rot.

The whole of the harvesting operations must be done with the utmost care, since the seed-pods are very brittle and careless handling entails a substantial loss of seed. From the time the first pods are nearing maturity, in December, until the seed is safely in the bags, which may not be until March, constant guard must be kept against the ravages of small birds. Further, close and continuous watch must be kept for the possible accidental introduction of the dry-rot fungus, so that, by drastic rogueing of all plants in the vicinity of an observed initial infection, the disease may be prevented from spreading in the crop.

Returns and Costs.

Judging by experience at Palmerston North the yield of seed grown in the foregoing manner should exceed 10 cwt. of dressed seed per acre; in one experiment nearly 12 cwt. was harvested from about three-quarters of an acre. The average value in the country of origin of imported swede and turnip seed is given in the import statistics for 1931 at very close to 1s. per pound. Since turnip seed is generally cheaper than swede seed it would seem reasonable to estimate 1s. per

pound as a basis for the wholesale price of swede seed grown in this country, even at the lower price-levels now ruling. A yield of 10 cwt. at 1s. per pound represents a gross return of £56 per acre.

On the cost side must be debited rent of land, equipment, and labour. With this system of production rent and equipment costs are comparatively low, the main expenditure being in labour. For this reason the industry is particularly adapted to small holdings, where family labour can be fully utilized. It is estimated that an average family should be able, where the crop is the main source of revenue, to handle efficiently 3 acres of seeding swedes, providing a cash return of about £150. This compares very favourably with the returns possible from any other source on this class of holding.

The main difficulties to be foreseen are, firstly, the doubt of producing high-grade disease-free seed by this system; secondly, the ability to sell it at a reasonable price when produced. Only experience can demonstrate how real are these difficulties or what methods are best to overcome them, but, under the present circumstances of the country, a limited trial of the possibilities appears to be thoroughly justified.

Preliminary Trials.

For the coming season it is proposed to utilize three 10-acre holdings under the Small-farm Plan. These holdings have been specially chosen as representing different classes of land, isolated from other crops, and within easy reach of the Plant Research Station. Three acres of each holding will be devoted to the swede seed crop, which is to be grown and harvested under the direct supervision of Mycological officers of the Station. The seedling plants will be grown at the Plant Research Station from dry-rot-free mother seed selected and bred at the Station. These seedlings will be distributed to the growers for planting out in June and July, and the seed crop will be harvested in the following January or February. Judging by results obtained at the Station over the last three seasons, the result should make available a supply of about 5 tons of seed. This seed will be taken over by the Department for disposal to the trade, the proceeds, less expenses, going to the grower.

Should this initial experiment prove satisfactory, and the resultant seed find favour with merchants and farmers, the foundation will have been laid of a new rural industry of great potential value. Such an industry because of its high per-acre value, large requirement of family labour, and low cost in equipment, is eminently suitable for the type of close settlement contemplated by the Small-farm Plan. Once successfully established its scope should widen to cover many other classes of seed, especially those in which freedom from seed-borne disease is of prime importance. If the infant industry is carefully controlled from its inception, under expert official supervision, there seems every likelihood that it will not only save New Zealand the £60,000 now spent abroad for these seeds, but that it may grow into a flourishing source of export. But of greater significance is the opportunity it offers to reduce the enormous annual economic loss caused by seed-borne plant diseases in this country.

ORCHARD SPRAYS IN NEW ZEALAND.

IV. THE ARSENATE SERIES.

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LEAD and calcium arsenates are used to-day in combating chewing insects, the object being to cover the fruit and foliage with a poisonous protective film. This method of protecting plant tissues was initiated in North America, where Paris green was used about the year 1867 to combat the Colorado beetle, and later against other chewing insects. As this compound was found to be variable in composition and relatively unstable, other materials—one of the best known being London purple—were tried as substitutes, but with little improvement until the introduction of lead arsenate. The marked advantages of this last, particularly when its manufacture became stabilized, led to its becoming the standard insecticide for combating chewing insects throughout the world.

The lead used in the manufacture of lead arsenate is relatively costly; consequently, in order to reduce the cost of arsenical sprays, numerous attempts have been made to place upon the market arsenates made from other bases, such as calcium, iron, zinc, aluminium, &c. Of these, calcium arsenate has given the best results, but a standardized product has yet to be secured.

There are several lead and calcium arsenates, and as these react differently towards insects and plants it is necessary to discuss them more fully and to indicate methods whereby their respective values may be assessed, and stability of spray applications brought about. For until such work is undertaken the orchardist has no means of assessing the relative worth of any arsenate offered for sale.

Lead Arsenates.

Lead arsenate was discovered by F. C. Moulton and introduced as an insecticide during the year 1893 for the control of gypsy moth in the State of Massachusetts, U.S.A. (Forbush and Fernald, 1896); and subsequent tests showed it to be superior to the earlier arsenical sprays for combating other chewing insects. At that time, and for many years subsequently, lead arsenate was thought to be a standard product; but varying results secured in the field forced workers to a realization that such was not the case, and recent chemical investigations (which are not yet finalized) have shown the existence of several lead arsenates. In fact, it has been shown that the chemistry of certain of these is decidedly complex, so that it is not possible to do more than speculate as to their composition.

Pickering (1907) appears to have been the first to investigate the matter, and demonstrated that two compounds were produced—acid lead arsenate ($PbHAsO_4$), when certain proportions of lead nitrate were added to a solution of acid sodium arsenate; and what he considered to be the triplumbic ortho arsenate ($Pb_3(AsO_4)_2$), when lead acetate was used in place of the lead nitrate. Since then workers have demonstrated that there are no less than six possible lead arsenates

(McDonnell and Smith, 1916 and 1917); but of these it appears probable that there are not more than two produced commercially, these being discussed more fully below. The others have been produced only in the laboratory, or occur possibly to a certain extent in certain of the commercial basic arsenates.

(1) Acid Lead Arsenate ($PbHAsO_4$).

This constitutes about 85 per cent. of the lead arsenate of commerce, and fully 98 per cent. of that used in New Zealand. This compound is usually known in the United States as "acid" lead arsenate—a term which has come into general use in the Dominion—but the preparation is more properly named diplumbic hydrogen arsenate or diplumbic ortho arsenate, terms which are scarcely likely to become popular with the orchardist, hence our choice and usage of this common name. Acid lead arsenate may be prepared commercially by one of several methods (the particular method is immaterial so long as the product is standardized) and possesses a theoretical composition of lead oxide (PbO), 64·29 per cent.; arsenic pentoxide (As_2O_5), 33·13 per cent.; water of constitution, 2·58 per cent. The ratio (by weight) of lead oxide to arsenic pentoxide is theoretically 1·94 : 1·0.

(2) Basic Lead Arsenate ($Pb_5(OH)(AsO_4)_3$).

Basic lead arsenate was first used in the United States, apparently by Volck (1911), on apple-trees in the Pajaro Valley, California. Since then it has had a limited application in that country (about 15 per cent. of the total amount of lead arsenates sold being this compound) principally on stone fruits, especially peaches. It has had practically no sale in New Zealand, owing to the difficulty of procuring a genuine product, those offered under this name being either acid lead arsenates or mixtures of acid and basic arsenates. In literature there has been considerable discussion as to the chemical composition of the basic lead arsenates of commerce. Pickering (1907), it will be remembered, claimed that the interaction of lead acetate and acid sodium arsenate led to the production of a salt with the composition of $Pb_3(AsO_4)_2$. Recent workers consider that it is doubtful if an arsenate of this composition is formed. On the contrary many (cf. Smith, 1916; McDonnell and Graham, 1917; Cook and McIndoo, 1924; Thatcher and Streeter, 1924) consider it to be composed largely of the more basic $Pb_5(OH)(AsO_4)_3$, or a mixture of this and acid lead arsenate.

Assuming that its composition is $Pb_5(OH)(AsO_4)_3$, then basic lead arsenate has the theoretical composition of lead oxide (PbO), 75·9 per cent.; arsenic pentoxide (As_2O_5), 23·5 per cent.; water of constitution, 1·6 per cent. The ratio (by weight) of lead oxide to arsenic pentoxide would therefore be 3·23 : 1·0.

(3) Colloidal Lead Arsenate.

Under this name a recent product of British manufacture has been placed on the New Zealand market. Analysis has shown that it is an acid lead arsenate containing approximately 50 per cent. by weight of water. The advantage claimed for it is that the particles are in an extremely fine state of division, and that this is the case has been

determined by analysis. As this product has not been tested other than on an experimental scale it is not yet possible to indicate whether its higher cost is warranted.

Calcium Arsenates.

It is not known when calcium arsenate was first introduced into commercial practice, but Pickering claimed that it had been used in the United States prior to 1907. This spray was first introduced with a view to lessening the cost of the arsenate sprays, since the calcium base is much cheaper than the lead used in the preparation of lead arsenates. When first employed it was thought that, like lead arsenate, it, too, was of relatively simple and constant composition; but recent work has demonstrated that three possible calcium arsenates exist, differing in their order of basicity. The first calcium arsenate was apparently an acid salt with the formula $CaHAsO_4$ (Lovett and Robinson, 1917). A second calcium arsenate with the formula $Ca_3(AsO_4)_2$ was claimed to have been produced by Robinson (1918); but recent workers (Thatcher and Streeter, 1924; Goodwin and Martin, 1926; Smith and Murray, 1931) are not agreed that this is the formula of the compound formed by his process. A third, strongly basic arsenate with the formula $Ca_5(OH)(AsO_4)_3$, was prepared by Tartar, Wood, and Hiner (1924). Smith and Murray (1931) analysed some sixteen commercial calcium arsenates, and as a result concluded "that the arsenic in calcium arsenate practically never exists solely as tricalcium arsenate, but that a considerable portion, and perhaps in some cases all of it, is present in the form of a basic arsenate of undetermined composition."

It is possible to produce commercially a calcium arsenate of constant composition with the formula $CaHAsO_4$. But this is unsafe to apply to fruit-trees, being too toxic to fruits and foliage, and as the manufacture of the more basic arsenates is not standardized (as is shown by the analyses given by Smith and Murray and those carried out with the products available in New Zealand) an improvement in this connection is necessary before they can be recommended in orchard practice.

Units of Measurement.

The object of this article is to indicate the units whereby the different arsenates may be measured in order that the orchardist may be able to interpret to his advantage those particulars placed by the manufacturer on the container, in compliance with the forthcoming regulations under the Fungicides and Insecticides Act of 1927.

(1) Percentage of Arsenic Pentoxide.

As the quantity of an arsenate used as a spray is determined largely by the percentage of arsenic contained therein it is important that this be expressed in some standard form. The arsenic content may be given in percentages of arsenic trioxide (As_2O_3), or of arsenic pentoxide (As_2O_5). Although many American manufacturers give this content as arsenic trioxide it is preferable to have it expressed as the arsenic pentoxide, as this is the form in which the arsenic occurs in the spray.

(*a*) *Percentage in Acid Lead Arsenate.*—It has been customary to recommend that acid lead arsenate be applied in the Dominion at the rate of 1½ lb. of powder (or 3 lb. of paste) to each 100 gallons of water, since this dosage has proved in the past to give satisfactory control of insect pests without appreciable injury to the tree. This recommendation has been made without regard to the arsenic pentoxide content of the arsenate, consequently it might be thought that considerable variation in results would be secured when different brands were used. Now, the quantity of arsenic pentoxide theoretically present in acid lead arsenate is 33·13 per cent., and analysis of the brands present on this market has shown that the commercial preparations agree closely with this theoretical figure, ranging between 30 and 33 per cent. This variation is surprisingly small and relatively unimportant (for if 24 oz. of lead arsenate powder is the required dosage based on 33·13 per cent. arsenic pentoxide content, then 26·4 oz. would be the dosage required when the arsenic content was 30 per cent.), so adjustment of dosage is unnecessary unless the analysis given on the package is below this minimum content of 30 per cent. arsenic pentoxide.

(*b*) *Percentage in Basic Lead Arsenate.*—A basic arsenate with the formula of $Pb_5(OH)(AsO_4)_3$ has a theoretical arsenic pentoxide content of 23·5 per cent. If this content were used as a measure of dosage, then 2⅛ lb. of the powder would be required to give comparable results with 1½ lb. of acid lead arsenate powder. Actually, however, it has been determined (Tartar and Wilson, 1915; Cook and McIndoo, 1924) that it requires approximately twice the quantity by weight of the basic salt to give results comparable with acid lead arsenate. It is evident, therefore, that the dosage of basic lead arsenate must be computed on a different basis, and that the arsenic pentoxide content cannot be used alone to assess comparable dosages of acid and basic lead arsenates.

(*c*) *Percentage in Calcium Arsenates.*—The arsenic pentoxide content of these sprays ranges between 40 and 44·5 per cent., being much higher than in the lead arsenates. Like basic lead arsenate, the dosage cannot be computed on this unit, since this would indicate that from 1 to 1⅕ lb. of powder per 100 gallons would be all that is necessary if compared with acid lead arsenate, whereas in practice it has been ascertained that this quantity is only moderately effective in combating chewing insects and is liable to cause severe spray injury. Consequently, until further work has been undertaken with the calcium arsenates, both on their chemistry and toxicity, it is not possible to indicate a satisfactory unit upon which dosage may be based.

(2) Lead Oxide (PbO) and Calcium Oxide (CaO) Content.

The bases lead oxide and calcium oxide are relatively worthless as insecticides, so do not afford a measure of dosage. But it is necessary to know the percentages present in the lead and calcium arsenates, as from them (and the arsenic pentoxide content) can be calculated the $PbO : As_2O_5$ or $CaO : As_2O_5$ ratios necessary to determine the acidity or basicity of each arsenate. Thus the $PbO : As_2O_5$ ratio (by weight) of acid lead arsenate is 1·94 : 1·0, and that of the basic lead

arsenate is 3·23 : 1·0. Consequently if the ratio of any brand is above that of the former and below that of the latter this indicates that it is a mixture of acid and basic lead arsenates. The more basic the arsenate the less toxic it is at any given dosage, and in consequence these figures are useful indicators as to the relative toxicity of an arsenate.

The ratios for the calcium arsenates differ according to their basicity, and as there is some uncertainty as to the chemical composition of the more basic calcium arsenates only ratios for the following can be indicated. Thus the $CaO : As_2O_5$ ratio of the acid salt $CaHAsO_4$ is 0·48 : 1·0; that of the tricalcium arsenate $Ca_3(AsO_4)_2$ is 0·73 : 1·0; and that of the basic $Ca_5(OH)(AsO_4)_3$ is 0·81 : 1·0. According to Smith and Murray (1931) it is not possible to determine these ratios until the excess calcium hydroxide and calcium carbonate added during or subsequent to manufacture is estimated. When these particulars were ascertained* for the three calcium arsenates available in New Zealand, it was found that the ratios of $CaO : As_2O_5$ were: Sample E, 0·89 : 1·0; sample K, 1·04 : 1·0; and sample N, 0·64 : 1·0. It is evident, therefore, that these three brands differ considerably in their basicity and, in consequence, in their effects upon insects and plant tissues. This affords another example of the necessity for further investigation into calcium arsenates before their use can be recommended with safety.

(3) Water-soluble Arsenic Pentoxide Content.†

As injury to plants is due to the soluble arsenic content it is necessary to use brands in which this has been reduced below a safe maximum amount. In the United States the insecticide regulations require that not more than 0·75 per cent. of water-soluble arsenic pentoxide be present in any arsenate; but this figure is too high for New Zealand, since the arsenical tolerance of most of our apple varieties is in the vicinity of 0·2 per cent. Therefore, if an orchardist chooses a brand in which the water-soluble content is below 0·2 per cent., he is scarcely likely to suffer spray injury from this factor. He should experience little difficulty in this respect, as analyses of the commercial arsenates available within New Zealand have shown that the water-soluble arsenic pentoxide content ranges from 0·04 to 0·67 per cent., most being 0·2 or less.

(4) Particle Size.

Although this has received little attention from investigators or manufacturers, particle size must be recognized as a factor affecting

* The Spray Chemist, Mr. P. J. Clark, Dominion Laboratory, Wellington, used for the purpose a process outlined by Smith and Hendricks (*Industrial Engineering Chemistry*, Vol. 16, p. 950, 1924) and, in addition, a simplified method which gave comparable results.

† When engaged on the determination of the water-soluble arsenic content of the commercial arsenates the Spray Chemist found that the standard process given in "Methods of Analysis of the Association of Official Agricultural Chemists," 3rd ed., p. 38, section 13, 1930, was not altogether satisfactory, as faulty readings resulted from the suspension of fine particles. In consequence he adopted the following modified procedure: The method outlined in the publication quoted was followed to the end of the fourth line, then portion of the filtrate was placed in centrifuge cups and rotated at high speed until clear. The supernatant fluid was pipetted off and the arsenic content of a portion determined by means of the Marsh apparatus.

the toxicity of an arsenate. This is evident when it is realized that upon this factor depends the amount of an arsenate taken into the gut of an insect by way of the mouth, and also the ability of the arsenate to adhere to fruit and foliage. Larvæ of insects often deliberately reject fragments of plant tissue carrying foreign substances of the nature of particles of arsenates, even when the latter are many times smaller than their mouth-parts. Although the mouths of freshly emerged larvæ of the leaf-roller caterpillar may range between 75 and 100 microns in diameter they are capable of rejecting minute particles of a diameter of 10 microns or so. The relatively high specific gravity of the lead arsenates is likewise a factor indirectly affecting toxicity, as dosage is directly affected owing to the readiness with which coarse particles fall from the surfaces to which they have been applied.

It is customary to express the size of the particles of an arsenate in terms of a certain sized mesh; thus a good quality arsenate is considered to be one in which 97 per cent. of the particles will pass a 200 or 300 mesh. As a 200 mesh would pass all particles less than 74 microns, and a 300 mesh all below 47 microns, it is evident that such units of measurement are comparatively worthless when the particulars set out in Table 1 are considered.

Consequently, at our request the Spray Chemist has elaborated a process* whereby it has been possible to measure particles to within much finer limits than is possible by sieving. This process has brought to light many interesting facts regarding particle size of the arsenates available on the New Zealand market, as the table shows.

Table 1.—Particle Size of Commercial Arsenates.

Particle Size, in Microns.*	Samples of Arsenates.										
	Lead Arsenates.								Calcium Arsenates.		
	A	D	F	H	L	P	Q	R	E	K	N
Above 74 microns ..	0·1	3·3	2·1	0·1	4·3	1·1	0·4	3·8	0·4	11·4	23·2
Between 74 and 10 microns	0·0	1·0	27·0	1·0	1·0	13·0	11·0	10·0	8·0	18·0	27·0
Total above 10 microns ..	**0·1**	**4·3**	**29·1**	**1·1**	**5·3**	**14·1**	**11·4**	**13·8**	**8·4**	**29·4**	**50·2**
Between 10 and 5 microns	0·3	3·0	21·0	4·0	7·0	16·0	22·0	13·0	31·0	20·0	11·0
Under 5 microns ..	99·6	92·7	49·9	94·9	87·7	69·9	66·6	73·2	60·6	50·6	38·8

* A micron is approximately $\frac{1}{25000}$ of 1 in. in length.

This table is significant, for it indicates that most particles present in a good quality arsenate are exceedingly fine. Thus sample A (a colloidal lead arsenate) has 99·6 per cent. and samples D and H (two widely used commercial lead arsenates) 92·7 and 94·9 per cent. respectively of their particles of a size of 5 microns or less.

If it be assumed arbitrarily that 10 microns is the effective maximum for particle size (a reasonable assumption when consideration is given

* Particulars of the process are being published by the Spray Chemist in the current number of the *New Zealand Journal of Science and Technology*, Vol. 14, 1933.

to the particulars outlined), then this affords one possible explanation for the conflicting results secured in the toxicity studies with arsenates. For even supposing they are of the same chemical composition, different brands of lead or calcium arsenates show considerable differences in particle size, as the table shows, and these must materially affect their relative toxicities. This factor may therefore be utilized as some measure of the relative efficacy (other particulars being equal) of the different commercial arsenates; but further work is necessary before it can be utilized as a basis for calculation of the dosage of any particular brand.

This factor of particle size may be utilized as some measure of the relative efficacy (other particulars being equal) of the different commercial arsenates; but further work is necessary before it can be utilized as a basis for calculation of the dosage of any particular brand.

(5) Powder versus Paste Arsenates.

Lead arsenates were first available in the form of pastes containing approximately 50 per cent. by weight of water; in recent years the majority have been offered for sale in powder form. Analysis and field trials have shown that the form in which arsenates are sold is immaterial provided equal concentrations, based on dry weight determinations, are used. But as the paste arsenates contain 50 per cent. of water they should be used at double the quantity of the powder, and consequently be sold at half the price. Powdered arsenates have several advantages over the pastes—they may be packed in cheaper containers, concentrations remain constant as evaporation does not occur, and they are easier to remove from the containers and prepare prior to adding to the spray tank.

Calcium arsenate dusts have been used to a considerable extent in the United States, and it has been claimed that they are easier to apply and less toxic to foliage than are the sprays. In New Zealand, however, these materials have proved most disappointing, causing severe injury, giving poor control of insects, and costing several times as much as the sprays.

Toxicity of Arsenates to Insects and Plants.

The degree of insect control secured, and of spray injury experienced, is dependent upon a complex series of interacting factors, of which the more important are outlined below.

Effects of Arsenates upon Insects.—Formerly it was thought that dosage could be computed upon the arsenic content alone, but it has been shown that this is only partially correct, since the effectiveness of the poison depends additionally upon whether the arsenate has a lead or a calcium base and is of the acid or the basic type. Thus recent toxicity studies indicate that it requires approximately twice the quantity of basic lead arsenate to give comparable results with a given quantity of the acid lead salt. Many investigators claim that the toxicity values of acid lead arsenate and the calcium arsenates are about equal, but this opinion is open to criticism on the grounds that little consideration has been given to the basicity of the samples tested. For if the toxicity varies with the basicity of a lead arsenate, the same probably applies with the calcium salts.

Before an insect can be poisoned it must take into the gut, and render soluble therein, a minimum lethal dose of arsenic pentoxide. This lethal dose is governed by many factors, for, in addition to those discussed, it is affected by the facility with which the arsenate is taken into the mouth, absorbed in the tissues of the gut, the rate at which it is excreted, the size of the particles and of the mouth-parts, the quantity applied and the thoroughness of the coverage secured. These factors may vary with the species of insect, the arsenate used, and the spray technique employed; consequently, before improvements are possible in the empirical methods and dosages employed, individual toxicity studies are necessary with each species of chewing insect present in the Dominion.

Effects of Arsenates upon Plants.—Scorching of foliage and russetting of fruits follow applications of arsenates when these are made under conditions that lead to liberation of soluble arsenic in the spray during its preparation and subsequently. This injury is affected by such factors as the water-soluble arsenic pentoxide content, whether an acid or basic lead or calcium arsenate is employed, the dosage used, the variety to which the spray is applied, the water used, and climatic conditions experienced during and following applications.

Thus, as we have seen, arsenates with a water-soluble content in excess of 0·2 per cent. are liable to induce injury on apples, since their arsenic tolerance within the Dominion is fairly low in comparison with other regions, such as the United States, South Africa, and Australia. With certain stone fruits—as peaches, for instance—injury is likely to occur even when the soluble arsenic pentoxide content is as low as 0·04 per cent. (Swingle, 1929).

Acid lead arsenate may be applied with safety (when both dosage and soluble arsenic content are considered) to all varieties of apples, pears, plums, and cherries, but is unsafe to use alone on apricots, nectarines, and peaches.

The quantity of the arsenate employed naturally affects spray injury, as might be expected. In many overseas regions acid lead arsenate may be applied at dosages of from 3 lb. to 6 lb. of powder per 100 gallons of water; whereas in New Zealand the maximum safe dosage appears to be 1½ lb., save in a few favoured localities, where 2 lb. may be applied. During the earlier part of the season the foliage will tolerate much heavier dosages than from midsummer onwards, whereas on fruits the converse is the case.

Certain climatic conditions may effect spray injury, such a combination as high humidity and high temperature tending to induce leaf and fruit injury. In fact, literature contains numerous references to spray injury resulting from some given set of meteorological conditions, but as any one factor is affected by one or several others little is to be gained by traversing them.

Finally it may be pointed out that whereas there is little risk of spray injury (when attention is paid to the features discussed) when acid lead arsenate is applied alone at the specified times and strengths, if the application is made combined with lime-sulphur severe injury may follow unless additional precautions are taken. The reason for this

has been the subject of considerable investigation, and while we are not proposing to discuss the matter at length here (combination sprays will be dealt with in a subsequent article) injury of this type has become so general that it is considered advisable to indicate methods whereby it may be prevented. (Given in the section "Recommendations," following). Injury of this nature is due to soluble arsenic in some form, liberated as the result of chemical interaction between the arsenate and the lime-sulphur. As a result of the reaction, which occurs only under certain conditions, the mixture turns a characteristic black colour (regarded by some orchardists as indicating a satisfactory mix), which is due to the formation of lead sulphide, and acts as an excellent indicator that interaction has taken place. Liability to cause injury is increased when a combination spray of this type, in which the black colour has appeared, is allowed to stand for some hours. The reaction does not occur when basic lead arsenate or calcium arsenates are employed.

Recommendations.

The following recommendations regarding the use of arsenate sprays are made until such time as further work, now being undertaken at this Station, enables us to effect further improvements and modification in arsenical spray applications.

Materials.

For general purposes an acid lead arsenate with the following approximate composition is recommended, as this enables applications to be made at the standard dosage of 1½ lb. of powder, or 3 lb. of paste, per 100 gallons of water :—

Arsenic pentoxide content	..	Between 30–33 per cent.
Ratio of PbO : As_2O_5	..	Approximately 1·94 : 1·0
Water-soluble As_2O_5	..	Not more than 0·2 per cent.
Particle size	..	At least 90 per cent. of particles to be 10 microns or less in diameter.

An arsenate of this composition, at this dosage, may be applied with safety to apples, pears, plums, and cherries ; but for peaches, nectarines, and apricots it is suggested that the dosage be reduced to 1 lb. of powder per 100 gallons of water, and that hydrated lime at 3 lb. per 100 gallons of spray be added to minimize spray injury. A basic arsenate, at the rate of 2 lb. powder per 100 gallons of water, would be preferable, but, unfortunately, a suitable brand is not yet available on this market.

Experiments conducted during the past three seasons have shown that the available calcium arsenates are unsafe to apply alone at dosages of from 1 lb. to 1½ lb. of powder per 100 gallons of water, as they are liable to cause severe spray injury. Injury may be reduced materially by the addition of from 3 lb. to 5 lb. of hydrated lime per 100 gallons of spray, but even then injury is liable to occur, though to a much lesser extent ; consequently, until methods have been evolved to render them less toxic to foliage or until improved brands are available, these arsenates cannot be recommended for general orchard applications.

Times of Application.

Applications of the arsenates are timed to coincide with the appearance of chewing insects against which they are directed, and thus a knowledge of their life histories, times of emergence, and number of broods materially aids in improving a spray programme. Many of these particulars are as yet unknown; consequently, until they have been worked out, the following tentative applications are recommended, since they are based on successful experiments conducted during the past three seasons throughout the Dominion.

In combating codlin moth, from three to seven applications are necessary, depending upon locality and season. The first application (the calyx spray) is made at petal-fall with a view to filling the calyx with arsenate so that subsequent entry of larvæ at this point is prevented. There is some evidence to show that in certain localities at least this spray is unnecessary, but until further work has been undertaken growers are advised to continue its application. The second spray should be applied 10 days later, and subsequent applications should be made at from three-weekly to monthly intervals until danger of infestation is past. In the Auckland Province the pest is more troublesome, and consequently ten-day to fortnightly applications are advisable.

For leaf-roller caterpillar on apples the programme used against codlin moth is all that is necessary. On stone fruits the first application should be made when the pest first appears, and subsequent applications made as required. With peaches, nectarines, and apricots the dosage should be reduced and hydrated lime added in the manner indicated; but even then a certain amount of spray injury is liable to occur, so that unless the pest is troublesome arsenic sprays should be avoided and control attempted with one or more applications of summer white oil at 1–100.

Bronze beetle may be combated with two close ratio applications when the pest first appears, usually between mid-November and the end of that month, followed by fortnightly applications until the insect disappears. Sprays should be supplemented by clean cultivation and removal of trash around the periphery of the orchard, since this has been demonstrated to be more effective than spraying in combating the pest.

Cherry slug may be combated by one or two sprays, applications being made as soon as the pest appears.

Reduction of Spray Injury.

To avoid injury with the combined lime-sulphur lead arsenate spray the mixture should be prepared in the following manner: Fill the tank with water, and to this add the required amount of lime-sulphur. To the required quantity of lead arsenate add three times its weight of hydrated lime; mix with water to form a thin paste, and pour into the spray tank while the agitator is running. Apply as soon as possible after mixing.

Those desirous of using calcium arsenate or acid lead arsenate on peaches, nectarines, and apricots are advised to use not more than the quantities recommended, and to add to the arsenate, prior to placing in the spray tank, from 3 lb. to 5 lb. of hydrated lime for each 100 gallons of water.

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BRUISING OF SHEEP AND LAMB CARCASSES.

SOME CONTRIBUTING FACTORS AND PREVENTIVE MEASURES.

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BRUISING of sheep and lamb carcasses is responsible for considerable economic waste in New Zealand year after year, and there is no doubt that it could be lessened to a very considerable extent. The importance of the matter may be judged by the reference to it in the last annual report of the New Zealand Meat-producers Board, also by the fact that a few months ago a special committee was set up by the Otago Provincial Council of the New Zealand Farmers' Union, following representations from several local branches, to consider the question of the bruising of lambs.

What happens at the freezing-works to a bruised carcass, depending on the degree of injury, is as follows: (1) Bruising may be so bad that the whole carcass has to be condemned; (2) bruising may be intense in one portion of the carcass, necessitating partial condemnation, and unless pieces are being exported from the particular works, the rest of the carcass cannot be exported; (3) bruising may result in the carcass being rejected for export; (4) bruising may cause a prime

carcass to be graded second quality; (5) bruising may be so slight that the grading is not affected, but nevertheless the bruise is still detrimental to the appearance of the carcass.

In Canterbury, Otago, and Southland, from the commencement of the present season to the end of February, 1,705,312 lambs were killed at the export meat-works. Of this number 95 were wholly condemned, 131 were partially condemned, 3,384 were rejected for export, and 12,911 were graded second quality, *all on account of bruising*. Assessing the difference between a first- and second-grade carcass at 2s. 6d., the number graded second quality on account of bruising represents a loss of about £1,600 in just over two months. The numbers just mentioned by no means account for the total number of carcasses bruised. They do not include carcasses that are graded second quality but not solely on account of bruising. Also the numbers do not include those carcasses where the bruising is not of sufficient degree to affect the grading.

A bruise or contusion is an injury of varying degree of the deeper parts of the skin and the underlying tissues, generally accompanied by an outpouring of blood from the damaged vessels, without the integument being broken. In the case of a dog-bite the integument is broken, and the lesion is more correctly called a contused wound. The simplest type of bruise is one in which the deeper layers of the skin only are damaged.

It is generally not realized how easy it is to bruise a sheep or lamb. A short time ago I was talking to the foreman butcher at a freezing-works, and he told me that he did not think it was possible for lambs to be bruised after they had come to the slaughtering board, as they were killed much too quickly afterwards. To show him that he was wrong I made an extreme case, picked up a lamb by the wool alone, put it down again, and the butcher killed it immediately. The result was a bruise sufficient to place the carcass in the second grade. This case merely illustrates how easy it is to bruise a lamb and how quickly the bruise shows. Practically the whole of the bruising met with in freezing-works is done within a week before slaughter, as I find by repeated experiments that even bad bruises have practically disappeared by the seventh or eighth day. In all probability the major portion is actually done within ninety-six hours of slaughter. Consequently the maximum care in all procedure is necessary during that period. The common location of bruises is along the back, over the shoulders, centre of the back, and loin.

There are many things that contribute towards the bruising of sheep and lamb carcasses, and the most important of these may be briefly mentioned as follows:—

(1) On the farm bruising may be caused by badly constructed fences, permitting sheep and lambs to squeeze tightly underneath them.

(2) Sometimes lambs get very dirty on feed and it is necessary to dag them before they go to the works. This may take place within a week, often within forty-eight hours, consequently the lambs require to be handled most carefully at this operation.

(3) Crowding lambs in drafting yards that are unsuitable for the purpose, when the buyer arrives, may be a fruitful source of bruising. The lambs, having been drafted and got ready for leaving the farm for

the works, do so by one of three methods in vogue: (*a*) They may be driven by road to the railhead and railed; (*b*) they may be loaded in motor-lorries on the farm; (*c*) they may be driven by road. From inquiries made, the highest percentage of bruising occurs in the stock that has been driven and railed; the next highest is found in stock brought in by lorry; and the lowest occurrence of bruising is among stock driven in. In other words, as one would naturally expect, the greatest bruising occurs in the lines handled most.

(4) It is a great mistake to drive or truck lambs straight off feed. It is desirable to hold them for approximately twelve hours in reasonably sized yards before being driven or trucked, as the case may be. The practice of trucking lambs straight off feed is too common.

(5) Lambs should not be trucked immediately on arrival at the railhead. They are hot and sluggish after being driven, requiring considerable effort to load them, and then many go down in the trucks. Another fault sometimes met with is that lambs are trucked several hours before the train is due to lift the trucks.

(6) Trucks should not be overloaded. The number of lambs that can safely be put in the trucks depends on the time of the season, the quality of the animals, the growth of wool, and whether the lambs are straight off feed or not. The capacity of the trucks is often severely taxed if a fall in schedule prices is anticipated. To illustrate overloading, the following authentic information may be given: 1,260 lambs were crowded into sixteen trucks (comprising thirteen J and three LA), with the result that nine were wholly condemned, forty rejected for export, and fifty-three graded second quality on account of bruising. Occasionally lines have been so badly bruised that it has been necessary to suspend slaughtering operations.

(7) On the other hand, trucks should not be underloaded, thus permitting too much movement.

(8) It is bad policy to truck sheep and lambs together.

(9) The trucks should be constructed in order to minimize bruising. This question was brought up at the inquiry held by the Otago Provincial Council of the Farmers' Union and referred to the Railway Department. The following information was subsequently supplied by the General Manager: "As regards the questions raised concerning the interior finish of sheep-wagons, these points were carefully considered when the later wagons were designed and provisions made to avoid projections of any kind. The wooden battens referred to are partly sunk into the uprights and the edges well rounded. Particular attention has been paid to the close fitting of the gratings against the side battens of these later wagons. It is possible that on some of the older wagons some improvement could be effected, and instructions have been issued to those concerned to ensure that these points are attended to as early as possible."

(10) The use of LA trucks should be avoided if possible. No gratings are provided, and lambs are likely to slip about more, and they also get excessively dirty.

(11) Plenty of time and patience is required for all loading operations, so that the stock are not handled unnecessarily. A considerable amount of bruising is done during loading operations, especially by catching lambs by the back and forcing them into trucks. This is often

done by inexperienced men, who do not realize the damage that results. It is easy to visualize what happens when an attempt is made to load trucks for a train due in a few minutes' time.

(12) Considerable care is necessary at all times when driving sheep or lambs for immediate slaughter. The human element is often at fault, especially when the stock have become tired and sluggish. A case recently came under notice of a number of bruised carcasses in a line of lambs. A drover had been seen to prod several of these with a stick when negotiating a bridge.

(13) The meat-export companies are not always entirely blameless in regard to the unloading of sheep and lambs conveyed by rail and lorries, but quite commonly their employees have years of experience of this class of work and their dogs are quiet and more or less trained for the purpose. One of the factors which is not conducive to careful work, though perhaps difficult to avoid, is the necessity in some instances of unloading late at night in all sorts of weather. Care should be exercised that neither sheep nor lambs are allowed to jump from the top deck of trucks or lorries, owing to the sudden jar on landing causing trouble. Another factor at freezing-works is the possibility of jamming sheep or lambs with the gate in a drafting-race. It is not necessary to handle so many sheep or lambs as in loading, so actually the amount of bruising done during unloading is very much less than that done during loading.

(14) Dog-bites are the cause of trouble in some lines. However, the lesion is generally of the nature of a contused wound, rather than a bruise only. The remedy is obvious.

(15) Freezing companies through their foremen butchers must exercise reasonable care on the slaughtering board in regard to the method of catching lambs adopted by the slaughtermen. The lamb should be caught by the leg or underneath the neck, and never by the wool on the back. I consider that there is less of a particular kind of bruise popularly termed "wool pull" along the back of lambs under the chain system of killing as compared with the solo system.

The problem of bruising is one for the co-operation of all those concerned with the handling of stock—on the farm, during transit, and at the freezing-works—so that appreciable improvement may be effected and the present economic loss materially reduced.

Tung-oil Trees in Nelson District.—Mr. R. E. Binfield, Fruit Inspector, Nelson, reports as follows: "During the year 1929, 125 tung-oil trees (*Aleurites Fordii*) which had been raised at Te Kauwhata Horticultural Station were forwarded to Nelson for distribution. These were planted out by the Waimea County Council, Nelson City Council, and the Cawthron Institute on different classes of soil in this district. None of the trees grew successfully. Although the majority established themselves well, the young shoots were usually killed by frost or deer. The few remaining trees that have survived do not seem to be suited to local conditions. It would appear from these tests that growing tung-oil trees as a commercial proposition could not be recommended in this district."

SLOW DEVELOPMENT OF ACIDITY IN CHEESE MANUFACTURE.

INVESTIGATION OF A TYPICAL CASE OF "NON-ACID" MILK.

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EXCESSIVE slowness in the development of acidity in the cheese-vat during the manufacture of Cheddar cheese is so common an experience with cheesemakers that they have coined the term "non-acid" to describe milk which exhibits the phenomenon. Soon after the beginning of the manufacturing process in a vat of such milk a delay in acid production becomes apparent. Thereafter the whole process becomes disorganized, and it may take two or three hours over the normal time to reach an acidity in the region of 0·9 per cent. of lactic acid in the whey which drains from the curd. In many typical cases of the trouble it is evident that the "starter" culture is not at fault, since only one vat out of three or four in which the same starter culture has been used may show the delay in acid development. The phenomenon for the most part makes its appearance during the warmer months of the season and is spasmodic in nature, days of normal running being interspersed with days when the trouble is experienced. This intermittent occurrence makes the diagnosis of the cause of the trouble very difficult, for the phenomenon often disappears during the course of investigations.

There have been many surmises as to the cause of the phenomenon. The layman has been inclined to postulate the presence of alkali in the original milk; but, although an excess of alkali is undoubtedly undesirable, this explanation in the case under discussion is hardly feasible, since an amount of alkali adequate to produce the delay in production of titratable acid which is observed would be sufficient to render the milk abnormal in appearance to the naked eye. Attention also has been directed to the possibility of the presence in the milk of contaminant organisms which produce alkali during their growth. Morgan and Curle[1] showed that organisms of the type of *Bacillus subtilis* when present in a starter culture ultimately led to a loss in its vitality, so that when the culture was used in a cheese-vat a delay in acid production ensued which simulated the delay usually associated with non-acid milk. They suggested that an active starter added to a vat of milk infected with *B. subtilis* would be affected in a similar way, but they did not show by experiment that this was the case. Mr. P. O. Veale (newspaper articles) has expressed the opinion that large numbers of organisms of the *Lactis aerogenes* type in milk interfere with the production of acid by starter organisms, but he has produced no experimental evidence in support of this contention. Up to the present time, therefore, no satisfactory explanation has been advanced for the failure of an active starter to produce acid at a normal rate in a cheese-vat.

The following preliminary account deals with a case of non-acid milk from which an organism was isolated capable of so affecting milk during its growth that subsequent production of acid in the milk by a starter culture was markedly delayed.

An opportunity for the study of this phenomenon arose in January of this year. Trouble with non-acidity had been experienced for several months at a certain factory in which four vats of milk were being made into cheese daily. Although on some days all the vats progressed normally, it frequently occurred that one of the first two vats to be filled gave a markedly delayed acid production. The same starter was used for all the vats. The manager suspected that the trouble was associated with the milk of one supplier, because he had noticed for some time that it occurred in the vat into which that particular supply was run. As a start in the investigation samples of the milk of the first fourteen suppliers were taken in sterile bottles and transported, packed in ice, to the laboratory. They were all subjected to the vitality test described previously by Whitehead and Cox(2), the factory starter being used in all the samples. The following results were obtained :—

Table 1.

	Suppliers.													
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
	Acidities as Percentage of Lactic Acid.													
First reading ..	0·40	0·30	0·33	0·32	0·30	0·32	0·32	0·32	0·19	0·29	0·29	0·28	0·23	0·12
Second reading ..	0·71	0·66	0·66	0·64	0·65	0·69	0·63	0·66	0·39	0·66	0·63	0·66	0·54	0·14
Increase ..	0·32	0·36	0·33	0·32	0·35	0·37	0·31	0·34	0·20	0·37	0·34	0·38	0·31	0·02

It will be observed that the whey draining from thirteen of the curds gave reasonable increases in acidity, whereas the whey from Sample N gave practically no increase whatever. This sample was taken from the supply of milk (comprising 200 gallons) which the manager had suspected. The abnormal milk was tested by Dr. F. H. McDowall for the presence of common preservatives with negative results. The following day the experiment was repeated with similar results. On this occasion, however, samples of the morning and evening milk delivered by Supplier N were subjected separately to the vitality test with the following results :—

Table 2.

	Acidities as Percentage of Lactic Acid.		
	Morning Milk.	Evening Milk.	Control—Normal Milk.
First reading	0·19	0·14	0·32
Second reading ..	0·33	0·14	0·69
Increase	0·14	0·00	0·37

The fact that the evening milk gave a more complete inhibition of acid production than the morning milk suggested that the phenomenon might be due to a bacterium which needed time to develop in the milk before its effect became evident. Both morning and evening milk samples had a normal acidity, but both contained large numbers of organisms as indicated by microscopic examination and by rapid decoloration of methylene blue in the reductase test (2 hours and

15 minutes respectively). The samples were plated on yeast whey agar incubated for twenty-four hours at 30° C. Both gave a profuse growth of bacteria in which two main types could be distinguished by the naked eye—namely, a large grey colony which proved to be that of a gram negative coccus, and a small clear colony which proved to be that of a gram positive coccus indistinguishable from a lactic streptococcus. The organisms were both isolated in pure culture, and their possible connection with the "non-acid" phenomenon was tested by means of the following experiment:—

A quantity of uncooled fresh evening milk from the Massey Agricultural College milking-shed was divided into three portions. To one portion was added a culture of the gram negative coccus (NL), to the second was added a culture of the streptococcus (NS), and the third was kept as a control. The three batches of milk were left at room temperature overnight, and on the following morning half of each batch was pasteurized at 145° C. for thirty minutes. A vitality test with one starter throughout was then performed on the three raw and three pasteurized samples, with results as below:—

Table 3.

	Acidities as Percentage of Lactic Acid.					
	Raw.			Pasteurized.		
	N.L.	N.S.	C.	N.L.	N.S.	C.
First reading	0·41	0·17	0·39	0·32	0·13	0·36
Second reading ..	0·62	0·21	0·59	0·53	0·15	0·56
Increase	0·21	0·04	0·20	0·21	0·02	0·20

At once it became evident that growth of the streptococcus had rendered the milk and curd inhibitory towards the starter, while the growth of the gram negative coccus had produced no measurable effect. The slightly smaller apparent effect in the raw milk sample containing the streptococcus as opposed to the pasteurized sample was probably due to the presence of contaminant acid-producing organisms which supplemented the activity of the starter. Where, as in the pasteurized sample, the starter alone was the acid-producing agent the power of the inhibition was really remarkable. The experiment was repeated on several occasions with similar results. The extent of inhibition in any single instance was directly related to the extent of growth of the streptococcus. The only way of preventing the appearance of the phenomenon in milk once infected with the organism was to cool it to such a low temperature that growth could not take place. Conversely, the higher the temperature at which the milk was kept overnight (up to a maximum of 80°–100° F.) the more marked was the inhibition of the starter the next day.

Coincidently with the work in the laboratory, trials had been made in the factory of different methods of treating the abnormal milk. It had been found that flash pasteurization to a temperature of 170° F. did not suffice to render the milk normal, and that the vat progressed slightly better when the milk was used in the raw state. However, neither mode of dealing with the milk was satisfactory. Some experiments were performed in the laboratory with artificially infected

milk with the object of determining whether the inhibitory effect could be eliminated at still higher pasteurizing temperatures. Various tests were made, but the following typical experiment serves to indicate the final result.

Milk in which the streptococcus (NS) had grown overnight was divided into two portions, one of which was pasteurized at 145° F. for thirty minutes, the other steamed for thirty minutes. These milk samples were then added in various proportions to normal pasteurized milk and the mixtures subjected to the vitality tests.

Table 4.

—	Percentage of Steamed Inoculated Milk in Normal Pasteurized Milk.				Percentage of Pasteurized Inoculated Milk in Normal Pasteurized Milk.				Control Pasteurized Milk.
	10	20	30	40	10	20	30	40	
	Acidities as Percentage of Lactic Acid.								
First reading ..	0·32	0·29	0·23	0·20	0·26	0·20	0·16	0·15	0·33
Second reading..	0·60	0·47	0·33	0·26	0·47	0·30	0·21	0·18	0·54
Increase ..	0·28	0·18	0·10	0·06	0·21	0·10	0·05	0·03	0·21

Previous experiments had shown that the addition of 40 per cent. of normal steamed milk to normal pasteurized milk had no measurable effect on acidity production. It will thus be observed that the retarding effect in the above experiment was in direct relation to the amount of inoculated milk present in any of the mixtures, and that, although weaker after the milk had been steamed, it was by no means eliminated by the treatment.

It became clear, therefore, that the streptococcus isolated from the non-acid milk produced during its growth in the milk some substance which tended to restrain the growth of lactic streptococci, and hence the production of acid. The substance formed was not completely destroyed even by heating at temperatures in the vicinity of 212° F. for thirty minutes. It is evident, therefore, that when such milk is received in a factory there is no practicable method of heat treatment which will render it satisfactory for the manufacture of cheese. The only means of control known at the present when the milk has become infected is to cool to as low a temperature as possible so as to delay the growth of the organism.

The characteristics of the streptococcus responsible for this phenomenon are still being investigated. The coccus is rather small in size and is indistinguishable from many of the organisms present in starters. During its growth in milk it produces acid at a slow rate, and usually clots milk after four to five days at 30° C., the milk then having a total acidity of 0·5 to 0·6 per cent. of lactic acid. It is quite active in the reduction of methylene blue in milk. It produces no flavour in milk, and its presence cannot be detected by any feature of the curd produced in the Wisconsin curd test. Milk infected with the organism produces a curd exactly like that obtained from a clean milk containing very few acid-producing organisms. When more information is obtained about the properties of the inhibitory substance produced by the organism it is possible that some method of eliminating the inhibitory effect may be found.

While investigation of the phenomenon was proceeding in the laboratory, the farm on which the abnormal milk was produced was visited. The conditions of milk production proved satisfactory in almost all respects so far as could be judged by visual examination. The milking-shed was clean and well kept, and the only criticism that could be made was that the cooling of the milk was not really efficient. The only feature on the farm which could be suspected was the water-supply, which was drawn from a surface spring and piped to the cow-shed. The milking-machine was flushed with this water immediately before milking started, so that there was no doubt that organisms present in the water would find their way into the milk. Samples of the water were taken, and various quantities were added to normal milk in the laboratory. After being allowed to stand at room temperature overnight the milk samples were subjected to the vitality test. On the first occasion on which this was done there was some inhibition of acid production in the samples to which the suspected water had been added, but the results were by no means so clear cut as in the case of the abnormal milk. At that time the causative organism had not been isolated from the abnormal milk and the water samples were not plated on a medium on which the streptococcus (NS) would have grown readily.

Subsequently it became impossible to obtain samples, and when water samples were finally taken a month later no evidence of the presence of the causative organism of the non-acid phenomenon was found. In the meantime the farmer had changed the source of his water-supply for the milking-shed and the trouble at the factory had disappeared. There is thus some slight evidence to connect the "non-acid" streptococcus with the spring water, but it is far from conclusive. Isolation of the organism from some material other than milk or isolation from the udder of a cow will be necessary before complete proof of its habitat is available.

Summary.

From a typical case of "non-acid" milk an organism was isolated which, upon inoculation into normal milk, reproduced the phenomenon. The causative organism was a streptococcus indistinguishable in appearance from a lactic streptococcus.

It was shown that the non-acid phenomenon was due to some product of the growth of the streptococcus, and that this inhibitory substance was not destroyed even when non-acid milk was heated to 212° F. for thirty minutes.

The only practicable way of preventing the appearance of the phenomenon in milk once infected was to cool the milk to such a low temperature that growth of the organism could not take place.

The habitat of the organism on the farm was not determined with certainty. There was a little evidence tending to connect the organism with the water from a spring.

Our thanks are due to Mr. G. A. Cox and Mr. J. D. Sargent for assistance with some of the experimental work.

References.

(1) Morgan and Curle: *N.Z. Journal of Agriculture*, 1928, 37, 305.
(2) Whitehead and Cox: *N.Z. Journal of Science and Technology*, 1932, 13, 304.

THE CHEMISTRY OF WEED-KILLERS.

(Continued from February Issue.)

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Dangers of Sodium Chlorate.

COMMERCIAL sodium chlorate ($NaClO_3$) consists of small white crystals which resemble those of common salt (sodium chloride, NaCl). The names of these two compounds are similar, but their properties are very different, and of course they are used for entirely different purposes.

Sodium chlorate has in recent years come on to the market as a weed-killer, and has been distributed in relatively large quantities in countries where intensive agriculture is practised. To those who have passed through a chemical course of training the more familiar salt is potassium chlorate, with which students delight to demonstrate the nature of an explosion by gently rubbing the chlorate with sulphur, when the two substances combine under pressure between pestle and mortar, resulting in a series of sharp reports.

Sodium chlorate is superior to potassium chlorate in two important respects, being much more soluble in water and therefore more easily made into a solution, and containing more oxygen. Potassium chlorate is superior to sodium chlorate in supplying a plant-food potassium, one of the three essential fertilizer ingredients recognized by the New Zealand Fertilizers Act.

The properties of these two compounds may be compared as follows :—

Name.	Formula.	Percentage Composition.	Solubility in 100 Parts Cold Water.	Percentages of available Oxygen.
		Per Cent.		
Potassium chlorate	$KClO_3$	K, 32 Cl, 29 O, 39	6	39
Sodium chlorate ..	$NaClO_3$	Na, 21·6 Cl, 33·3 O, 45	94	45

The chlorates are made by the action of chlorine on caustic soda or caustic potash. Hence the raw materials are not available from New Zealand sources at present, and the sodium chlorate all has to be imported, Germany, the United States, Sweden, and France being some of the exporting countries. An impure calcium chlorate is on the market as a weed-killer under various names, but it is so diluted with the by-products of manufacture that it cannot be considered in comparison with the potassium and sodium salts.

The dangers attending the use of sodium chlorate are intensified by the novelty of the compound's characters to the farmer. That

such innocent-looking sugar-like crystals should on being mixed and heated or rubbed with organic materials such as clothing, woodwork, flooring, pelts, bagging, casks, hay, chaff, flour, sulphur, or other dry combustibles cause them to burst into flames practically impossible to quench in time to avoid extensive injury is quite a new experience to the land worker. In handling a good many other modern inventions —high explosives and flying-machines, for instance—there is no room for even one mistake in learning the technique of safe use, and similar caution must be shown in dealing with chlorates as weed-exterminators. It is essential that farmers shall carefully study the conditions necessary to ensure safety to all workers and combustible property when using chlorate, either as a solid or as a solution in water.

Sodium chlorate contains 45 per cent. of available oxygen, a gas which is present in the atmosphere to the extent of one-fifth of its volume. When a solution of chlorate is sprayed on to clothing or woodwork the water soon evaporates, but the chlorate remains intimately mixed with the fibres of cotton, wool, or wood. This may now constitute an explosive mixture, or at least one which is liable to instantaneous ignition, and which may also be set off by a spark or even by intense sunlight, or by concussion or friction. When the material mixed with the chlorate is once alight there is no time to extinguish that portion saturated with the compound. One can only prevent the flames from spreading to adjacent material which is not so impregnated. When combustible matter burns in ordinary air it is due to the materials or the air being raised to a temperature sufficiently high to enable chemical combination to take place between the two. The air must therefore be in contact with the substance to be burnt, and fresh supplies of air must be continuously available if burning is to continue. By cutting off the supply of air the burning is checked, and if the exclusion is complete the fire is extinguished.

Ordinarily when a person's clothes catch fire the quickest way to extinguish the flames is to wrap the subject closely in a blanket, rug, mat, carpet, sack, or even a bystander's coat in order to cut off the air and oxygen supply. In the burning of chlorate-saturated clothes the oxygen is already present in such intimate contact with the material that the ignition is extremely rapid. Wrapping the subject up may not hinder the combination of the oxygen from the chlorate with the combustible matter of the clothing. One would prefer to advise workers to wear such loose clothing in such a way that in emergency these could be stripped off with the least possible delay. Actually the combustion of the chlorate-saturated portion is so nearly instantaneous that there is no time for preventive measures once the fire is started.

Added to these dangers is the ease with which any dry combustible saturated with chlorate may become ignited. It is not necessary for a naked flame or even a spark to touch the mixture of substances, since friction, a blow, or even direct sunlight may cause spontaneous combustion. The astonishment of the farm worker who hung his wet trousers on the line to dry in the hot sun and subsequently saw them burst into flames must have been as great as his luck in not occupying the garment at the critical time. Another worker found his seat on horseback becoming hot due to the setting on fire of his clothes rubbing the saddle.

The *Hawera Star* of 12th August, 1931, records that at Ararata "while Mr. Richard Buckley's trousers were drying before the fire recently they exploded with a loud report. Although partially stunned by the force of the explosion, he had sufficient presence of mind to seize the garments and hurl them from the house, where they smouldered on the lawn with a series of minor detonations. The action of sodium chlorate," adds the paper, "is considered responsible for the catastrophe."

A serious burning accident in the field, caused by a man's trousers previously impregnated with sodium chlorate becoming ignited at a fire he had lit to boil the lunch "billy," was recorded by Mr. J. W. Deem in this *Journal* for January, 1931. The danger that saturated clothing when dry may become an explosive mixture also increases the risk of fire, while contributing an added menace from the shock of explosion or detonation.

The difficulties of transporting sodium chlorate are increased by the fact that it cannot be contained in combustible bagging, casks, or barrels without danger; it should be carried only in iron railway trucks, since a leakage on to a wooden truck floor would be dangerous and difficult to remedy entirely. When the original iron drum is opened only metal vessels should be used for holding the chlorate or the solution. Zinc (galvanized) vessels or zinc-lined vessels are unsuitable. All containers which have held chlorate should, when empty, be thoroughly washed out with water.

Even when unmixed with inflammable matters sodium chlorate is liable to explode by percussion and friction in the same way as chlorate of potash. Hence sodium chlorate should be handled with care, and not dropped on to a concrete, tiled, or iron floor, or subjected to any violent blow.

The technique in the use of chlorates as weed-killers will no doubt be improved in the future, but it is essential that any method having official sanction may be as nearly as possible "fool-proof," so that if the instructions are strictly adhered to there will be no danger to life or property. It is possible that the method finally adopted may seem cumbersome, and shorter ways may be proposed and even extensively used, but the official method must be designed to meet all conditions which may arise, so far as is humanly possible, in order to protect the farmer and his property.

Some persons have taken advantage of the fact that mixtures of sodium chlorate and combustible substances are highly explosive to utilize such mixtures as explosives on the farm; but to make such an explosive without a license is contrary to law. The Chief Inspector of Explosives has intimated his intention to prosecute in any such case brought under his notice.

Several parcels of chlorate have been transmitted through the post. This is also contrary to law; and under section 107 of the Post and Telegraph Act, 1928, such an offence is punishable by imprisonment or by a fine, or both.

(To be continued.)

NOTES ON RECENTLY OBSERVED EXOTIC WEEDS.

H. H. ALLAN, Systematic Botanist, Plant Research Station, Palmerston North.

(2.) Three Leguminous Shrubs.

THE three plants here dealt with are all shrubs occasionally grown in gardens for the sake of their pea-like flowers. While they are not at present causing any great trouble, they have certain objectionable features that make it desirable to draw attention to their occurrence as wild plants. In common with many leguminous shrubs they have a somewhat bitter taste, which at times has its attractions for stock.

Oxylobium Callistachys.—This is a tall Australian shrub, with leaves about 2 in. long, arranged in groups of three. The leathery leaves are

FIG. 1. OXYLOBIUM CALLISTACHYS.

[*Photo by H. Drake.*

strongly veined, and more or less hairy below. The young branchlets are silky-hairy. The flowers are yellow, sometimes flushed with red, and are arranged in dense panicles at the tips of the branches. The pods are small, silky when young, and becoming very hard when ripe. The form found wild in New Zealand (Fig. 1) resembles that often called *O. retusum* in gardens.

The genus contains several more or less poisonous species, though there appears to be no record of the present species having caused trouble to stock. Mr. M. Hodgkins, who discovered the plant at Birkdale near Auckland, informs me that it is to be found among manuka scrub. Around the adult shrubs seedlings in all stages of growth are to be met with. I should be glad to have my attention drawn to any other occurrences of plants answering to the description

and figure. The genus *Gastrolobium*, also Australian, contains species of very similar appearance, and some of these are considered to be extremely poisonous.

Pultenaea daphnoides.—This is another Australian shrub, reaching some 6 ft. in height. The branches are almost erect, giving the plant a rather besom-like appearance. The leaves are a little over 1 in. long, widest near the tip, where there is an abrupt pointed process. They taper gradually towards the base, and are arranged alternately along the stems. The flowers resemble those of broom, are arranged in dense heads at the tips of the branches, and are orange-yellow with a dark purple blotch.

This plant has escaped in various parts of North Auckland, and tends to become established in open manuka country. It has several times been sent in for identification. Mr. Hodgson has also sent specimens from manuka scrub near Titirangi.

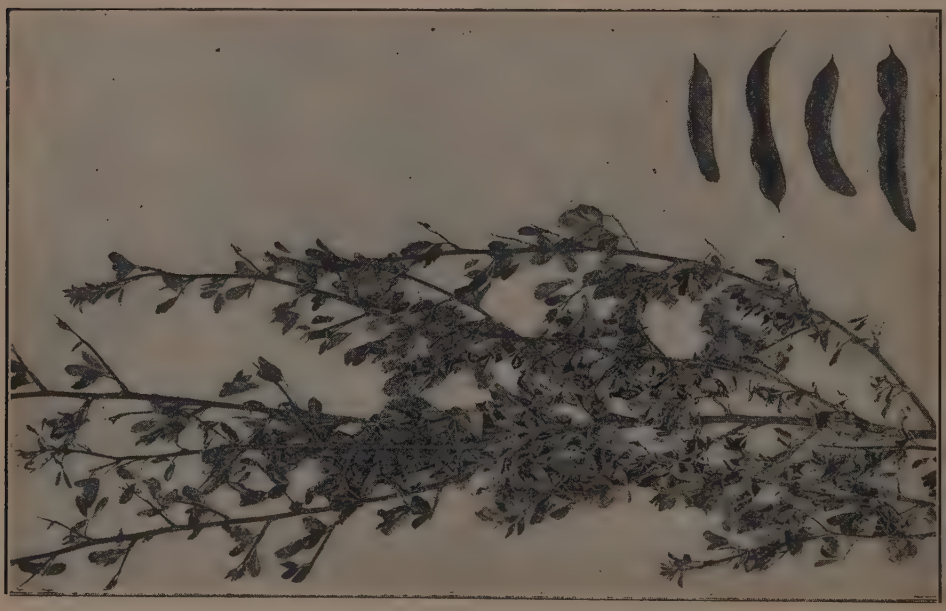

FIG. 2. CALYCOTOME SPINOSA.

[*Photo by H. Drake.*

Calycotome spinosa.—This Mediterranean species (Fig. 2) forms a spreading bush with stiff branches bearing spiny processes. The leaves are three-foliate, as in the clovers and brooms, and the yellow flowers are also broom-like in appearance. The pods have narrow wings along one side. The shrub flowers and seeds freely, the flowers being distributed along the branches.

The plant has established itself along several roadsides in the immediate neighbourhood of Palmerston North, and tends to extend its area.

SEASONAL NOTES.

THE FARM.

Pre-winter Top-dressing.

On all those farms on which adequate top-dressing has not been carried out earlier one of the most important matters which will commonly call for attention in April and May is suitable top-dressing of pastures. The importance of such top-dressing is linked with the following facts :—

(1) Unnecessarily poor yields of meat, wool, and butterfat, and increased ravages of disease both may be attributed partly to poor feeding of stock in winter and early spring.

(2) It is now too late to adopt some of the most useful measures for economically making sound the feed position in the critical winter and early spring period, and thus top-dressing, the main suitable measure which remains available, intensifies in importance. In this connection phosphates are of outstanding importance.

Quickly acting phosphates applied in April or early May may be expected to bring about an almost immediate increase in the rate of grass growth. This would often result in stock entering upon the severe part of the winter in better condition, and further, throughout much of the winter and early spring the autumn top-dressing will cause increased grass-growth, which will assist to check unduly rapid falling off in condition. When the critical spring period is passed, the influence of fertilizer applied in the autumn is partially exhausted, and so the great rush of feed in late spring and early summer that often follows early spring top-dressing does not occur. As this rush of feed frequently leads to inefficient utilization of the surplus growth, its absence is commonly a distinct blessing.

To sum up, the fundamental merit of pre-winter top-dressing with phosphates is that it tends to even out the rate of grass-growth throughout the whole year, and, as a rule, manures are used to the best advantage on New Zealand grassland when they do this to the greatest possible extent.

The period during which the fullest advantage is obtainable from pre-winter top-dressing is drawing to a close, and especially in the colder districts any considerable further delay in carrying it out is distinctly undesirable. If top-dressing is not carried out until close to the season when grass-growth is at its lowest point, then the top-dressing approximates in its ultimate effect to spring top-dressing and some of the value of pre-winter top-dressing as described above is lost.

When it is necessary to spread top-dressing over both autumn and spring it is usually preferable to select for the autumn dressing pastures which are relatively well drained, well sheltered, and rich in rye-grass. This is because such fields are better fitted to respond to stimulation under cold conditions. Pre-winter top-dressing is preferable at times especially in sheep-farming, because the dressing of broken or rolling country tends to be more difficult and costly after winter rains have made the land soft. Further indication of the needs of pastures in respect to top-dressing was given in last month's notes.

Liming.

When liming is advisable it may as a rule be carried out suitably in April or May. Approximately 2 tons of ground limestone are equivalent in their ultimate effect on the soil to 1 ton of burnt lime. Provided the amount of limestone used is approximately twice the amount of burnt lime, from the evidence available in regard to the effect on grassland, it

seems immaterial whether burnt lime or ground limestone is used. In purchasing lime it is advisable not only to make allowance for the relative values of the different forms, but also to consider the bearing of these values on the cost of transport—heavy transport costs operate against the use of ground limestone. Indeed, when the cost of carriage of lime becomes heavy, then the advisability of using any form of lime tends readily to become questionable unless the land is specially in need of liming. The present practice in liming is towards relatively light dressings of, say, 5 cwt. an acre, repeated at comparatively short intervals, instead of the heavy dressings with long intervals between which were favoured by many in years past.

If within a short period lime and fertilizer are to be applied to a field separately, it is considered preferable to do the liming first, as by top-dressing in this order there is some opportunity for the lime to become well distributed in the soil, and thereby to be able to obviate any undesirable action between soil and manure which might occur in the absence of the lime. If desired, superphosphate and ground limestone may be mixed and applied in one dressing, but superphosphate and burnt lime should not be mixed unless the mixture is to be applied immediately. Lime naturally descends in a soil and so tends to be washed out and lost. Hence ordinarily the working of lime into a soil is inadvisable in that it hastens the loss.

The matter probably of greatest current moment in regard to liming is that it is exceptional for liming alone to give good results, and the reduction of farming expenditure by substituting lime for phosphates in top-dressing is generally unsound practice.

Care of Young Pastures.

Newly established pastures call for careful treatment, the essence of which is the avoidance of the extremes of undergrazing and of overgrazing. To keep the young growth suitably short it is usually well to use in grazing a relatively large number of stock for a short time. This avoids the prolonged hard grazing of the most attractive species, and the neglect of other species which is apt to occur when light stocking, which allows of selective browsing, is practised. Prolonged close grazing of young pastures is likely to be very harmful because it prevents the plants from building up the strong extensive root-systems upon which the future vigour of the pasture depends. On the other hand, if young pastures are allowed to become long and possibly productive of flower heads, then some of the slower-developing species which are particularly valuable in permanent pastures are likely to be weakened and possibly, in extreme cases, destroyed. The damage from undergrazing is apt to be specially serious when Italian rye-grass and red clover are to some extent prominent in the pasture, for these temporary species outgrow and consequently injure the slower permanent species by shading. Properly controlled grazing leads to early stooling out of the plants, and thereby intensifies the density of the sward.

Special care should be taken to keep stock off young pastures when the ground has become soft on account of rain, for the poaching which readily occurs on such ground facilitates establishment of weeds.

At times when valuable species such as perennial rye-grass do not establish as well as might be expected, an autumn dressing of about 1 cwt. of sulphate of ammonia per acre, usually in conjunction with 2 to 3 cwt. of superphosphate, may be advisable to assist in bringing about successful permanent establishment.

Harrowing of Pastures.

The fact that farmers in older countries attach a high value to animal manure should carry a useful lesson to the many New Zealand farmers who make little or no effort to utilize effectively the supply of animal

manure available to them in the form of the droppings on grassland. Efficient utilization of such manure calls merely for its thorough distribution, without which the manure tends to harm instead of to benefit the grassland. Thorough distribution is readily effected by suitable harrowing, which at this season is often urgently needed, because the longer animal droppings remain undisturbed the greater will be the subsequent development of those rank patches of growth which indicate poor utilization of the manure.

Future Provision of Special Feed.

At this season it is advisable to be carrying out field work in conformity with a planned programme of special feed provision. In drafting a programme of feed provision it is important not to place too much dependence on what can be provided next season by means of ensilage, unless there already exist sufficient reserves of feed to tide over the normal critical periods even should an unfavourable season lead to a failure of ensilage. Ensilage is an excellent means of placing surplus grass-growth in reserve, but to count definitely on the surplus being available is such a risky practice that sufficient arable cropping to make the year's feed provision secure should find a place in the programme of work for the coming year.

Of seasonal interest in respect to such arable cropping is the fact that the mangel, when grown after grass, often gives the largest and most profitable crops as the result of May ploughing. Such ploughing gives enough time for the complete mellowing and mixing of the sod with the remainder of the soil. This begets increased fertility which is valuable in mangel growing, because high fertility and high mangel yields are intimately correlated. If it is not practicable to plough at this season, then suitable measures such as skim ploughing or disking in the spring will be advisable to assist in disintegrating the sod.

Autumn preparatory cultivation is also frequently worth while for such crops as potatoes, carrots, and lucerne, especially when these crops are to follow old pasture. The first step in such cultivation should usually be skim ploughing, followed possibly by disking to break up the sod thoroughly and leave the ground in a suitable state for the normal deep spring ploughing. Because of the value of timely preparatory cultivation of this type, it is fortunate that lea land can at times be worked safely when adjoining similar land which has recently been under the plough is too wet.

Autumn Utilization of Crops.

During the period leading up to winter, as well as during winter itself, feeding practice should take into account the fact that immature stock are likely to suffer more acutely and permanently from hardship than would mature animals. Because of their immaturity, calves and hoggets call especially for good attention during winter. Calves should be trained to eat such feed as hay and silage while they are still in good condition and before they will have to live almost wholly on these feeds. By timely introduction of unfamiliar feeds into their keep the calves will be spared the set-back which sudden substantial changes in feed at times bring about.

Hoggets also should receive the best possible treatment, and be given access to fodder crops before they have become low in condition. Changes in their feed should take place gradually, and if at all possible they should be allowed a run-off on a short fresh pasture.

One of the blemishes of our dairying is the winter feeding of the cows on the production of which so much depends in the following season. In the minds of many farmers the feed requirements of the dry cow seem, regrettably, to be confused with the feed requirements of the

store steer. The real difference between the feed requirements of the two animals may to some extent be gauged by the fact that in one producing season the cow forms from the feed it consumes at least twice as much solid matter as the steer produces in its whole life. From this it follows that the strain and drain on the cow during the producing season is much greater than it is on the beef animal, and that in the feeding of the cow this difference should be taken into account. Translated into practice this means that in the season when the cow's production ceases, or is low, she should be fed material which enables her to build up bodily reserves which stand to her during the producing season. To create such reserves the good cow needs to be well fed when she is not actually producing just as much as when she is producing heavily. It is known that cows which have proved themselves to be outstanding producers have shown ability to milk-off bodily condition, and their high production apparently is dependent to some extent on this ability. The point of practical moment is that the ability is worthless unless the feeding is of a type which enables it to function. In other words, producing ability without good feeding during the low production period does not carry one far. From this it is clear that it is generally an error to keep cows on short rations through most of the off-season.

Generally, autumn and winter grazing of lucerne brings about appreciable deterioration, and as thriving lucerne is such a valuable crop such grazing of good stands should be avoided if at all possible. On the other hand, if lucerne has become badly invaded by plants such as rye-grass and clover which provide useful feed, then it may be sound practice to utilize the lucerne area chiefly as a grazing field from which it would probably be possible to obtain up to three cuts in the year, in the first of which lucerne would not be a prominent constituent.

—R. P. Connell, Fields Division, Palmerston North.

THE ORCHARD.

A Working Programme.

WHEN these notes appear not only will the main rush of export work be over, but the harvesting of fruit generally will be almost finished for the current season. There will, however, be little relaxation as regards work for the successful fruitgrower, for it is necessary that the many operations that require to be put into practice and completed during the winter months be pushed on with as little delay as possible. It is suggested that a working programme be thought out by each individual grower, so that when one job is finished the next can be put into immediate operation, thus saving much time and confusion. It is also suggested that whenever possible each job, once commenced, be completely finished before a fresh one is started. All work that can be done under cover should be set aside and carried out on wet days. Even at this early date, if there is nothing else of importance to be done, cases for the 1934 export season can with advantage be nailed together and labelled, and stacked away in readiness in a dry position.

The more important autumn and winter work to be done may be listed as follows: After-harvest clean-up, including orchard sanitation; spraying of stone fruits; drainage; cultivation and manuring; new plantations and shelter.

After-harvest Clean-up and Orchard Sanitation.

Advantage should be taken of each fine day in cleaning up the orchard by collecting all unused or broken boxes and parts thereof, rubbish, including rotten and decaying fruit and mummified remains of stone

fruits, props, &c. It is important that anything in the nature of mummified or rotten fruit or rubbish be destroyed by burning or burying deeply.

Trees affected with silver-leaf should be destroyed forthwith, otherwise they are easily overlooked once the foliage has disappeared. In orchards where fireblight was prevalent during the past summer a minute inspection should be made for cankers, and where these are located they should be immediately removed by cutting the branch well below the canker and destroyed by burning. It must be remembered that one canker, if not detected and destroyed, is capable of reinfecting a whole locality with fireblight during the next blossoming season.

The mending of broken orchard boxes, stacking away props, an overhaul of the grader, and a general clean up of the packing and grading sheds is work that can be done on wet days.

Spraying of Stone Fruits.

It is advisable that stone-fruit trees be sprayed in autumn with a 5–4–50 bordeaux spray for the better control of brown-rot, leaf-curl, die-back, &c. Before doing so, however, the trees should be carefully examined and all cankered and infected shoots, laterals, mummified fruits, and branches removed and destroyed by burning. This should be looked upon as a very important work, for it is a well-known fact that many of the fungus diseases overwinter by means of hibernating mycelium in cankers on laterals and branches, conidia lodged in bud scales and in infected shoots, and spores in mummified fruit lying on the ground and hanging on the tree. It is also advisable at this time to remove surplus growth inside vigorous and congested stone-fruit trees, with the object of opening up the trees so as to enable the buds to ripen and the wood to harden for next year's crop.

Drainage.

The importance of adequate drainage cannot be overstressed; the natural trend of an open drain, if not cleaned out to the original depth each year, is to gradually fill up, and in this way the level of the under ground water is raised. Where this occurs an unfavourable subsoil condition is set up, which is subsequently reflected in the general health of the fruit-trees. The outlet drain, which is usually an open one, should be done first, and care taken to clean it out to its original depth, or, better still, deepen it if at all possible. Where this is done the lateral drains, whether tiled or otherwise, if carefully laid with a decided fall to the outlet, will function perfectly. If the original drainage scheme is at all faulty or inadequate immediate steps should be taken to remedy the fault or lay new drains.

Cultivation and Manuring.

It is advisable as soon as possible after the leaves have fallen to plough the orchard as deeply as possible without injury to the roots by throwing a furrow up to each row of trees; the finishing furrow of each land will then come midway between the rows of trees, leaving a more or less temporary drain capable of carrying off excess surface water. This work should be finished before the winter frosts set in. Cover crops should be turned in as they come to their flowering period. A periodical dressing of lime, up to 1 ton per acre, is beneficial to most soils. Manures such as superphosphate and sulphate of potash, if applied just before the deepest ploughing, will give the best results—from 2 to 4 lb. superphosphate, plus from 1 to 2 lb. sulphate of potash per tree for trees of, say, from eight to ten years old. Successful manuring depends not only on selecting the best combinations of fertilizers, but also on the judgment and care bestowed in applying them to the best advantage. It is better to manure a few trees thoroughly than a whole orchard insufficiently.

New Plantings and Shelter.

It is presumed that those growers who intend to add to their orchard acreage or make replacements where necessary will have already placed their orders for trees. Providing the land has been well worked during the preceding spring and summer, and that climatic conditions are favourable, autumn planting carried out during the month of May is to be recommended. However, it is very unwise to plant if the soil is in a very dry condition or if it should happen to be overwet. Should autumn planting be impracticable, plant as early in the spring as the situation will allow, and preferably before growth commences.

The distance for planting is an important consideration and should be governed by the nature of the land. Pears and stone fruits on the better class of land should be planted about 20 ft. apart, cherries 25 ft., and apples from 18 ft. to 20 ft. apart. Adequate shelter-belts must be established, and be well maintained in every district, irrespective of the kind of fruit grown.

—J. W. Whelan, Orchard Instructor, Palmerston North.

Citrus Culture.

Where fresh plantings are proposed it is essential that adequate shelter be provided beforehand, as young trees will make no headway when exposed to cold or strong winds from any direction; and if not given every care and attention during the first two or three years they will never make satisfactory trees when full grown.

In the selection of a site for planting, where possible only well-drained land facing the sun should be utilized, and if not naturally drained artificial drainage should be adopted. Owing to the surface-rooting habit of citrus-trees anything approaching a waterlogged condition is fatal. The land should be ploughed and subsoiled as early as possible, so that planting in the autumn can be done in localities that are free from frost. A dressing of lime should be given as soon as the land is ploughed, and if it is desired to carry out spring planting the rows can be left in the rough, and the spaces between sown in cover crops for ploughing in. The more time given to the preparation of the soil, the better the result in the growth of the trees.

In preparing a citrus orchard for the winter it is not advisable to plough deeply, owing to the risk of cutting the surface roots to the detriment of the growing tree. As an alternative a light disking would be preferable.

A light pruning can be carried out by the removal of unproductive worn-out wood and water-shoots, together with any crowded growths that may be interfering with the normal development of the inside fruits. This will ensure a minimum amount of discomfort when picking.

—L. Paynter, Orchard Instructor, Auckland.

POULTRY-KEEPING.

Care of the Pullets.

THE season is now at hand when maximum prices rule for strictly fresh eggs. As the great bulk of the adult birds will be resting and undergoing the moulting process the pullets must be chiefly relied upon to produce these eggs. It is therefore imperative that the pullets be given the best possible attention to enable them to produce.

Perhaps the main point in the management of the pullets that are bred to lay in winter is to prevent them from going into a premature

moult. In this connection the worst mistake that can be made is to change the quarters or change the diet, more especially when the bird is commencing to lay. As a matter of fact, any change in the method of feeding and general management is simply inviting the birds to moult. If a good egg-yield is to be expected it is necessary that the pullets should have everything in their favour. In the first place the house must be roomy, so that the birds will have ample space to exercise under cover when cold and wet weather conditions prevail. They should be fed in the house at all times, and induced to exercise as much as possible by being compelled to scratch in any litter for their grain ration.

Poultry-keepers should never practice the false economy of giving the laying pullets a mere living diet. If the birds are to produce to their maximum capacity they must not only be liberally fed, but, in addition, the food must be of the best possible quality. It will be necessary to add by degrees some forcing diet, such as meat, meat-meal, &c., to the ration, but the poultryman should not on any account let the increasing price of eggs tempt him to unduly force for eggs with such foods until the birds are well settled down to their business. Especially is this the case where a rich diet is included in the mash mixture. The only safe course is to provide the forcing material sparingly in the mash mixture, but this can also be provided in a separate receptacle, and left before the birds at all times to pick at. In this way each bird can take what it wants and no more. The bird is thus given an opportunity to balance its own ration, and usually she can be depended upon to do this better than we can do it for her, as what she likes is usually what she needs for producing her maximum egg-yield. Where a bird is forced to eat in a mash an excess of any forcing material in order to secure a meal ovarian troubles such as protrusion of the oviduct will result, as well as the production of shell-less and double-yolked eggs. Poultry-keepers who have a supply of last season's wheat should reserve this as far as possible for the pullets, as a sudden change from old to new wheat will probably bring on a premature moult.

When the pullets are first put into their winter quarters the houses should be visited for the first few nights to see that none of the birds are sleeping in odd corners of the house, for once they acquire this habit it is difficult to break them of it. One should also make sure that there is no sign of the birds sneezing, &c., indicating that colds are present. Where this symptom is observed the cause should be looked for and removed. Colds are mostly due to birds sleeping in a draught, or in badly ventilated quarters, whereby the house becomes overwarm by night and leaves the birds susceptible to chill immediately they go out of doors in the morning. If a bird contracts a really bad cold it should be isolated at once and treated, as a cold is the forerunner of that dreaded disease roup.

No care and attention is too good for the pullet that is expected to lay in winter. Above all, uniform and regular attention is imperative if the best results are to be obtained, as one day's neglect is apt to throw the bird back for weeks and probably months to follow.

Feeding of Moulting Hens.

Now that the hens are moulting, one should not on any account endeavour to economize in the food bill by giving the birds a mere living diet. It is better to reduce the flock by half and feed the birds thoroughly than to put the whole flock on half rations. Feed may be high in price, but nothing will be saved by stinting the moulting hen. Never forget that in the process of renewing her feathers the bird's system is put to a severe tax. Obviously, if a good moult is to be gone through and early egg-laying promoted the food should not only be good, but must be liberally

supplied. The moulting birds should be protected from exposure to cold and wet weather. Never compel them to stand in a cold, wet yard waiting for feeding-time, as such exposure of a half-naked bird must obviously have an undesirable effect on it. As is the case with birds of all ages at this time of the year, they should be fed in the house, so that they may secure all the food they require without having to go out into the open on cold, wet days.

Gizzard Compaction.

In spite of repeated warnings against supplying fowls with long fibrous material such as long grass, lawn clippings, &c., several cases have recently come under my notice of mortality in laying flocks due to no other cause. While lawn clippings make an ideal green food for fowls when they are short and succulent, they are liable to have a decidedly injurious effect on birds of all ages if provided in a more or less long fibrous condition, as they become a tangled mass and will not leave the gizzard. In the great majority of cases reported to me regarding losses in stock from this cause the owners observed that the birds usually dropped dead at feeding time from no apparent cause—birds which in most cases were in a heavy producing condition and gave striking evidence of being in a healthy thriving state.

The suddenness with which birds die from this trouble frequently leads their owners to believe they had picked up some kind of poisonous matter, but this is not so. Of the many post-mortem examinations the writer has conducted in investigating this mortality, usually the heart was found to be in a badly ruptured condition, and the gizzard packed with fibrous material such as long pieces of grass, while in some cases the gizzards contained husks of oats, barley, &c., and little or no grit. What caused the heart to rupture is difficult to say, but it would appear that this was first due to compaction of the gizzard with fibrous material causing the digestive system to become deranged, then excessive blood-pressure resulting from excitement at feeding time, followed by a ruptured heart. In most cases that have come under my notice of late lawn clippings have been responsible for the mortality, while in others the deaths were due to the birds eating grass hay which was used as litter, and this had a similar effect in packing the gizzard.

Once this trouble shows itself in a flock the only safe course is to withhold from the ration as far as possible any grass, lucerne, green oats, &c., which is not in a decidedly succulent form and finely chaffed. Other foods with husks on, such as oats, barley, &c., should also be eliminated for a time from the ration. The birds will then be given a better opportunity of freeing themselves from any fibrous matter that may be contained in the gizzard. At such a time the green material should consist solely of silver-beet, cabbage, rape, or similar tender plants. Above all it should be seen that plenty of sharp stone grit is within reach of the birds at all time. It should never be forgotton that fowls have no teeth and require this grit to aid digestion. Sea-shell will assist in this direction, but if gizzard and crop disorders are to be avoided gravel or stone grit should be provided as well.

—F. C. Brown, Chief Poultry Instructor, Wellington.

THE APIARY.

Management of Supers.

As recommended in last month's notes, the removal of the supers should go on steadily as the bees form their winter clusters. In the case of very strong colonies it will often be found difficult, if not impossible, to confine the bees to one story without seriously diminishing winter stores and unduly crowding the bees. In these cases it is best to leave the supers on till the spring.

The best place for winter stores is in the hive, and however careful the beekeeper may be in replenishing these, if the honey is removed from the hives he still runs the risk of allowing the bees to starve out if the honey is not within their reach at all times during the cold weather. There are very few districts in New Zealand where brood-rearing absolutely ceases during the winter, especially when the hives are well sheltered, and the bees require food at all times and seasons. On no account should they be allowed to winter in more than two stories. In many cases they will be showing a tendency just now to go as high as they can get in the hives, and where this happens it will usually be found that the combs in the bottom story are deserted and dry. A rapid examination will soon show the beekeeper whether this state of affairs obtains, and, if so, he should remove the bottom story, leaving the cluster undisturbed.

Where queen-excluders have been left on the hives they should be removed, because it sometimes happens that the bees will go through the excluders to the stores above, leaving the queen to perish below. There is always a tendency for the cluster to move to the warmer part of the hive, and an excluder will not act as a bar if the bees are dissatisfied with the lower story.

Mats for Wintering.

To ensure that the bees are kept warm through the cold weather it is absolutely necessary that the frames should be well covered with good mats. Three or four are by no means too many to provide for each hive. Ordinary corn-sacks cut into pieces the size of a zinc queen-excluder answer the purpose admirably, and are very durable. Avoid using calico mats, as these are next to useless for wintering purposes. It is essential that the mats should fit exactly over the frames; if too small they admit draughts, and if too large the edges will protrude beyond the hive-covers, and in wet weather these will absorb sufficient water to cause the mats to become damp and unhealthy and the combs mouldy.

Clearing Weeds.

Weeds should be kept down in the apiary. A good clearing round the hives in the autumn will suffice until the spring, and will add materially to the comfort of the bees and well-being of the hives during the winter months. Not only should the entrances be cleared, but the ground all round the hives should be similarly treated, and the weeds raked up and destroyed.

Care of Utensils.

Utensils that have been in use during the extracting season should be thoroughly cleansed prior to storing away for winter. Remove all traces of honey from the extractor, tanks, uncapping knives, &c., wash with boiling water, and dry thoroughly to prevent rusting. All metal parts liable to rust should receive a coating of oil. The cost of renewing working equipment is becoming a serious burden on the profits of the apiary. Prices are steadily increasing, and there is every probability in the near future of certain supplies being unobtainable. By a little judicious care and management the life of a beekeeper's working equipment can be prolonged; much of the expense incurred in replacing damaged utensils is usually the result of sheer neglect. Loose washing covers should be made to cover the extractor and tanks in order to prevent these utensils getting coated with dust, which is likely to accumulate during the off season.

Care of Hives.

At no other season is the welfare of the hives of such importance as during the next few months. Every hive should be raised from the ground the height of one brick, and if the situation is damp or low-lying it is a good plan to raise the hives still more. This will tend to keep them

free from slaters (woodlice) and other insects, and will afford less harbour for mice, as well as ensuring that the hives have a free current of air beneath the bottom boards and thus will be more likely to keep dry. Never rest the bottom-boards on the ground, or they will rot in a very short time and become mouldy and evil-smelling.

Before bad winter weather sets in it is a good plan to give a coat of paint wherever it is needed, at the same time stopping up all cracks in the supers. Cracks afford ventilation during the summer months, but they are hardly to be advocated on that account, because the beekeeper will usually find that towards the end of the honey-flow the bees will use up much valuable time in gathering propolis to paste up the cracks in view of the approach of winter. The hives should be slightly canted forward, so that any rain which falls on them will drain off the alighting-board.

Leaky Hive-covers.

Apart from disease, there is no worse feature in an apiary than the presence of leaky roofs. A cover which allows moisture to trickle through is a constant menace to the colony it appears to shelter. Not only will the mats immediately beneath it become sodden and mouldy, but the cluster of bees in the hive stands in danger of extermination when frost sets in. There will then be pollution on the bottom-board, where the intruding moisture mixing with dead bees and waste pollen forms a rotten fermenting mass, with a stench which the order-loving bees must find even more obnoxious than does their owner.

There is no excuse for leaky covers. In the autumn the apiarist should examine them for any doubtful spots, and should either cover them with zinc, ruberoid, or some other waterproof material, or, if economy must be practised, he should cover with cheese-cloth, applying to the roof first a coat of paint, then the cheese-cloth, and then another coat of paint. This makes an effective waterproofing, and one which anybody can apply.

—E. A. Earp, Senior Apiary Instructor, Wellington.

HORTICULTURE.

The Planting Season.

DURING every month in the calender sowing and planting are done to some extent, but the five months of May to September inclusive are popularly referred to as the planting season. It is then that, in addition to the sowing and planting of some herbaceous plants and bulbs, deciduous and evergreen trees, shrubs, and climbing plants may usually be transplanted to best advantage; ornamental trees and fruit-trees; shade trees and shelter trees; vines and fruiting shrubs.

This season affords a great opportunity if it is taken up in the right spirit. Trees are set which may stand for one or many hundred years, or bear fruit for generations. Many a grove stands to-day that is obviously composed of trees wisely chosen and well placed, and is a fine monument to the sterling worth of a pioneer, who will certainly not be forgotten so long as the trees stand. Thoughtless planting is not merely a waste of time, money, and land, but a good opportunity missed. Treated with the consideration that is due to its importance, and taking full advantage of the accumulated local experience, it is safe to prophesy that some wonderful achievements of this kind will be made here, where the varied topography, soil, and climate are so suited for work of the best description.

Tree-shelter for vegetable crops was referred to in these notes last month, but shelter and shade trees are of first importance to the homestead, the live-stock, and the crops in all parts of the farm, apart from its other

uses. The height, width, length, and position of these shelter-belts each demands the most careful consideration as well as the selection and arrangement of the trees. In most districts there are sufficient successes and failures to demonstrate every possible result, and these should be studied in a leisurely way. They will generally point to a solution that avoids most of the mistakes and includes some of the most successful features. The local data are of first importance in making these decisions. The Department's Bulletin No. 131, "Hedges and Shelter-trees," contains further information on this subject.

In these notes for the month of March the soil and climate suited for the different kinds of nut-trees were described. It is important to observe these conditions when planting, as although the trees may live and thrive after some fashion under other conditions it is unlikely that they will be really satisfactory, and that is always to be avoided. Whatever may be the object for planting, it will invariably be best achieved if the selection of the kinds and varieties of plants is made from those which are really suited to the environment, as one then has nature on one's side. Besides a useful food crop for "man or beast," these trees have other uses. Chestnut palings have an age-long reputation for their lasting qualities, and walnut wood and hazel boughs have qualities that are a by-word; they also serve a useful purpose on the lee side of shelter plantations or as shade trees.

Other points of importance in this connection are the purchase of trees required, planting, and maintenance. Generally it is wise to select plants of moderate size that are well rooted, and to take delivery as soon as possible after the commencement of the planting season. Like any other live-stock, they must receive immediate attention when they are delivered. If they have been packed close and been some time on the journey, open them up at once in a shed where they will be sheltered from wind and sun, check them over, water the roots as may be necessary, and cover them with wet sacks. Let them stand like this over-night to cool in case any heating has taken place. They may then be planted out according to plan, or, if the land or weather are not in suitable condition for the work at the moment and some days will elapse before it can be done, they must be heeled in. To do this, dig in friable soil a trench of sufficient size to comfortably contain the roots when the plants are lined out closely, but not too crowded, and when the trees are in position fill in the soil about the roots and make it firm. In this position the trees will stand for months without injury, more especially the deciduous kinds.

At a convenient time, in fine weather and when the land is quite free from any tendency to be sticky, planting may be done. Where a large number of trees are being handled there is danger of them having the roots exposed to wind and sun; sometimes they are even distributed along a planting row where they must lie exposed for many minutes before being planted. Such treatment causes serious injury, and where the plants are at all weak a total loss. During transit, and in the field before planting, the roots must be kept covered with wet sacking. Where trees are to be planted out in line for some distance, especially in uneven country, it is often convenient to erect sighting rods, as when ploughing; so long as two of these are in sight at once it is possible to keep the line, and if the rods are of a suitable length they can be used to measure the distance to the next row. Provided the soil is friable—and that is important—there is likely to be little difficulty in planting successfully, so long as the plant is set at the same depth as formerly, and the soil is well firmed with the feet.

One of the most important features in maintenance is to see that the plants do not become overgrown with more vigorous weeds and grass. Clean cultivation is desirable, but where this is not possible grass and weeds should be cut low shortly before seeding and allowed to lie as they

fall; the material then forms a mulch, which keeps the ground moist, and later on humus, which is one of the best manures. Shade trees and plantations must, of course, be fenced from stock, and this cost is one of the chief reasons why more is not done, but costs must always be considered in relation to the benefits to be received; and if it is done in this case it will be found that no other improvement is more profitable, while often a certain amount of shelter of this kind is indispensable.

Planting Small Fruits.

During the planting season loganberries and raspberries, currants and gooseberries, passion-fruit and Chinese gooseberries, tree tomatoes, feijoa, guavas, loquats, figs, and persimmons may be planted out where the soil and climate are suitable, which should be ascertained. These notes for the month of March contained information on the subject. Strawberries and Cape gooseberries are planted out respectively just before and after the planting season.

In the home garden some of these plants may be set out in the more ornamental parts. Feijoa or guava is sometimes planted as an informal hedge, and loquat, fig, or persimmon makes an interesting specimen on the lawn at most seasons of the year. For a trellis or pergola the passion-vine or Chinese gooseberry is quite at home, has a curious interest, and is decidedly useful. A common mistake to be avoided is to plant bush fruits among bearing fruit-trees or vegetable crops. They are sometimes recommended between fruit-trees when the trees are young, but even that is a doubtful suggestion in this country, where dwarf fruiting trees are the fashion. These bush fruits decidedly object to having their roots disturbed, and most of them prefer an open position. For these reasons they are best given a place to themselves in the home garden.

For commercial cropping bush fruits demand every consideration—first, that the general conditions are suitable, and second, that the ground has been well prepared. The soil should be friable to a good depth, well enriched with humus, given a moderate dressing of fertilizers (chiefly organic kinds) and be quite free from weeds that are likely to be troublesome. Clean well-selected plants set out in such conditions should crop well without much further attention except that of a routine kind.

Vegetables and Herbs.

Perennial crops of this kind which should be set out during the planting season are asparagus, rhubarb, and some of the herbs. Together with the small fruits, they make an interesting and useful section of the home garden.

Asparagus is a hardy plant which requires a light, rich, moist soil to be really at home. Under such conditions produce of the best quality may be obtained in the spring-time when there is usually a short supply and a lack of variety. Large areas are planted 18 in. between the plants and 5 ft. or 6 ft. between the rows; but for small crops in the home garden planting double rows is popular with 3 ft. or 4 ft. between each pair, the plants in the double rows being planted 18 in. apart both ways. The roots of this plant are fleshy and readily dry out; if this happens there will be a serious diminution of the crop, and very possibly a loss of plants. For this reason the planting should be carried out promptly and in the spring-time as soon as the land is in condition. An even lot of good strong roots should be selected for the purpose. Owing to their brittle nature, crowding or bending them must be avoided when planting. To do this a good wide trench should be opened. In light land it should be sufficiently deep to place the crown of the plant 8 in. beneath the surface; on heavier ground 5 in. or 6 in. will be deep enough. After placing the roots in position cover them only to a depth of 2 in. or 3 in., and allow the trench to be filled gradually during summer while hoeing is being done. At this time land should be prepared for planting if roots are available, or for sowing seed and raising

plants otherwise. For planting this long-lived perennial crop the preparation should be thorough and rich, as the matted roots usually afford little opportunity for deep cultivation later.

The rhubarb crop is less settled in its habits; after three or four years in one place the plants begin to go back and replanting is necessary. A portion of the crop of roots may then be lifted in early winter and, after exposure to a hard frost or two, placed in a dark damp shed with a temperature of 55°–65° F. Tender well-coloured sticks soon appear and are much appreciated. The remainder of the crop may be lifted in August, the fleshy roots divided into pieces with a couple of good buds in each, and planted out at once, covering them with 2 in. of soil, or if the land is light 3 in. or 4 in. The distance between plants and rows may be 3 ft. for Linnaeus and other varieties of moderate growth that are usually grown. This plant from the valleys of Siberia is perfectly hardy and best suited to cold localities. In readiness for planting out the ground should now be deeply cultivated and generously manured as for asparagus.

The use of herbs has rather gone out of fashion, but for fragrance and flavouring they are sometimes in demand. By those who take the culinary art seriously they may be used with the finest results. Many of these herbs, such as parsley, angelica, caraway, coriander, dill, and majoram, are grown as annuals, and may be sown in the spring; but perennial kinds for present planting are mint, tarragon (*Artemisia dracunulus*), wormwood (*Artemisia absinthiam*), balm, lavender, rosemary, rue, sage, savory, and thyme. Those preferring the moister positions are angelica and mint.

The Homestead Garden.

The planting season affords an opportunity for transplanting trees and shrubs of moderate size from different parts of the garden, which can often be done with good effect. Many lawns are over-planted, and if the majority of the plants were gathered up and planted in a compact group the appearance would be much improved and maintenance greatly facilitated. It is also the season when additions may be made to the shrubbery border, or new ones planted. Brightness, interest, or distinction may be given to what is otherwise, at some seasons, a rather dull border, by carefully placing a well-selected group of shrubs, palms, or tree-ferns, &c. The more shaded borders are most likely to need this attention, although there is no reason why they should not be almost as bright and quite as interesting as those getting more sunshine. Attractive shrubs requiring rather shaded conditions are diervillas (weigelas), flowering currants, hydrangeas, kalmias, pernettyas, camellias, fuchsias, daphnes, and Choisya ternata.

The present is also a suitable time for taking in hand the renewal of those herbacious borders which require this attention. Perennial herbaceous plants vary widely in the length of their life of usefulness: many, like the paeonies, dislike being disturbed and thrive for many years with little attention under right conditions. The shrubbery border is often a good place for such plants. The attractive hybrids of chrysanthemums, dahlias, &c., have to be treated almost as annuals to obtain the best results, and others have to be renewed every few years if their quality is to be maintained. Not only is is necessary to replant them to do this, but, as they require a high state of fertility, trenching in a generous quantity of organic manures is usually necessary. Few herbaceous borders can go for more than three or four years without this attention. The plants should then all be lifted, planted out in nursery rows in a piece of spare ground, and carefully labelled. The border under treatment should be manured, thoroughly trenched, cleaned of weeds, and allowed to settle before replanting it. When that is done it is advisable to rearrange the groups not only to obtain a good effect, but so that each occupies a fresh position.

—W. C. Hyde, Horticulturist, Wellington.

WEATHER RECORDS: MARCH, 1933.

Dominion Meteorological Office.

MARCH was, in the main, a very dry, warm, and sunny month. The eastern districts of the South Island suffered severely from the prolonged shortage of rain, and the situation was rendered all the more unfavourable there owing to the prevalence of hot dry north-westerly winds. In the North Island conditions were on the whole very good.

Rainfall.—The rainfall was irregular over the North Island, those districts which receive most of their rain from the west having, in general, good falls. In the far North, also, rain was above normal in most cases. In eastern districts there was a considerable deficiency. In the South Island the totals were considerably below average everywhere, except in parts of the south-west and extreme south. East of the ranges the average was considerably less than half that usually recorded in March.

Temperature.—The mean temperature was considerably above normal over the North Island, but in the South Island conditions varied, some places being warmer and some cooler than usual. There were some very warm days, particularly in Canterbury. Christchurch, for example, experienced its warmest weather for this summer, the maximum temperature exceeding 87° F. on both the 19th and the 21st. Some light frosts occurred, more especially in the South Island. The mountains were unusually clear of snow.

Sunshine.—Almost all districts experienced abundant sunshine, though Napier had rather less than usual. Nelson registered 283 hours, Blenheim 269, and Lake Tekapo 255 hours.

Pressure Systems. — Depressions of the westerly type passed fairly regularly during the month, and were the principal influence controlling the weather in the South Island. There was, however, continued activity in the tropics, as many as four cyclones originating in the area north of New Caledonia. Towards the end of the month, also, a tropical cyclone passed just south of Fiji, Tonga, and the Cook Islands.

Westerly depressions passed on the 3rd, 6th to 8th, 14th, 16th, 18th to 21st, 24th, and 27th. The most important was that of the 18th to 21st, which was complicated in form and consisted of several separate waves. Of the latter, those passing on the 18th and the 21st had considerable northward extensions and were responsible for almost general rains. Many heavy falls occurred in connection with both, though in most of Marlborough, Canterbury, and Otago, unfortunately, the rain was only light.

On the 21st exceptionally heavy downpours occurred during a northerly gale in the central and central-western portions of the North Island, especially in the Tongariro National Park and parts of the Tararua Range. At the Chateau Tongariro 7·16 in. were recorded, and at Mangahao 5·12 in., while there were many falls between 3 in. and 5 in. A sudden flood of unprecedented magnitude in the upper tributaries of the Wanganui River caused serious damage at Taumarunui.

On the 11th to 13th one of the tropical cyclones mentioned approached New Zealand as it passed by to the northwards. Gales and heavy rains were caused in the northern and north-eastern areas of the North Island.

Thunderstorms were widespread on the 21st, and some were reported also on the 6th and 18th.

RAINFALL FOR MARCH, 1933, AT REPRESENTATIVE STATIONS.

Station.	Total Fall.	Number of Wet Days.	Maximum Fall.	Average March Rainfall.
North Island.				
	Inches.		Inches.	Inches.
Kaitaia	1·62	11	0·67	2·94
Russell	2·94	8	0·95	2·77
Whangarei	5·29	10	2·10	4·23
Auckland	0·76	11	0·26	3·01
Hamilton	1·53	5	1·28	3·81
Rotorua	5·43	7	2·21	3·51
Kawhia	4·89	5	3·30	3·51
New Plymouth	2·29	10	1·32	3·75
Riversdale, Inglewood	5·28	10	3·12	7·12
Whangamomona	5·65	3	2·61	5·07
Hawera	2·25	7	1·13	3·23
Tairua	9·56	8	2·61	5·13
Tauranga	4·49	8	1·82	3·98
Maraehako Station, Opotiki ..	4·51	10	1·58	4·00
Gisborne	2·85	9	1·10	4·40
Taupo	2·30	6	1·08	3·19
Napier	2·04	8	0·55	3·16
Hastings	1·77	8	0·43	2·78
Taihape	2·89	9	1·31	2·69
Masterton	1·93	6	0·95	2·86
Patea	2·41	4	1·70	3·46
Wanganui	3·18	8	1·74	2·52
Foxton	2·59	4	1·80	2·05
Wellington	2·10	5	1·30	3·11
South Island.				
Westport	5·55	18	1·64	7·50
Greymouth	6·73	15	3·20	8·91
Hokitika	6·86	16	2·11	9·74
Ross	5·99	13	1·31	11·03
Arthur's Pass	..	..	..	11·38
Okuru	..	..	..	14·70
Collingwood	2·60	4	1·91	5·97
Nelson	1·26	4	1·10	2·96
Spring Creek	0·23	1	0·23	2·05
Hanmer Springs	1·22	5	0·70	3·28
Highfield, Waiau	0·62	3	0·35	2·89
Gore Bay	1·35	4	0·77	2·23
Christchurch	0·45	4	0·19	1·98
Timaru	0·59	7	0·30	2·24
Lambrook Station, Fairlie ..	0·48	4	0·28	2·38
Benmore Station, Clearburn ..	1·27	4	0·66	2·78
Oamaru	0·98	8	0·70	1·80
Queenstown	2·15	10	1·13	2·64
Clyde	1·27	4	0·96	1·50
Dunedin	1·01	8	0·41	2·94
Wendon	1·51	10	0·72	2·73
Gore	1·88	14	0·66	3·25
Invercargill	4·10	17	0·85	3·89
Puysegur Point	7·58	21	2·68	8·20
Half-moon Bay	6·12	20	1·04	5·52

ANSWERS TO INQUIRIES.

IN order to ensure reply to questions, correspondents must give their name and address, not necessarily for publication, but as a guarantee of good faith. Letters should be addressed to the Editor.

RAGWORT POISONING IN COWS.

H. B. I., Norsewood :—

Please tell me if the undermentioned symptoms are caused through ragwort poisoning : Cows very dopey-looking about the eyes, with eyes running and lids inclined to be puffy ; stomach very slabby and empty-looking ; cows stagger a good deal, the weakness seeming to be mostly in the fore quarters. Up to the present season I have been running both sheep and cows, but since putting the sheep off I find that about half the section is badly infested with ragwort. If it is the effects of the ragwort is there any cure for same, and are the cows likely to get all right again ?

The Live-stock Division :—

There is very little doubt that the symptoms described by you in your cows are the result of ragwort poisoning. The weakness and staggery symptoms mentioned indicate serious disturbance, from which animals do not readily recover. There is no specific cure for ragwort poisoning, but in cases which are not too far advanced recovery might follow immediate removal from the ragwort pasture. The following medicinal treatment might be tried in early cases : Give a drench of ½ lb. of sulphate of soda, dissolved in a quart of water, along with 1 lb. of treacle. Follow this with 2-dram doses of powdered nux vomica given dissolved in a pint of gruel once daily. As previously indicated, however, treatment is not likely to be successful in advanced cases.

IMPROVED METHODS OF CIDERMAKING.

H. G. LEVER, Tauranga :—

Referring to the extract on " Cidermaking and Cider Apples " in the February *Journal*, will you please explain what is the " Seitz filter " which makes the cider germ-free ; also what is the " centrifuge process," and how is it applied ? A clear explanation of these points would be very much appreciated amongst us here, as we are using up considerable amounts of apples for cider, and sometimes have very variable results without knowing why.

The Horticulture Division :—

The " Seitz E.L." filter, which is probably the one referred to, is manufactured by Theo. Seitz, of Vienna, Austria, and contains a filtering medium that retains both ferments and nitrogeneous matter from the cider that is passed through it. It is so constructed that the liquid passes through at a quicker rate than through the usual type of germ-proof filter. The filter is used with the object of stopping fermentation while the juice still contains some of the natural sugar of the apple. Successful experiments with this method have been carried out at the Cider Institute at Long Aston by Otto Grove, and it is now adopted by commercial cidermakers in England. The centrifuge process is used for the same purpose, and this method is preferred by Prof. Warcollier of the Cider Institute of Caen, in Normandy. A separator somewhat similar to that used for cleaning milk is employed. These methods are used for producing a still cider suitable for holding as such or for carbonating, and they may be employed to advantage where considerable quantities of cider are turned out. It is claimed that ciders produced in this way have a superior flavour to those made by the usual methods.

Pear Varieties and Fireblight.—A district officer of the Horticulture Division reports that in Canterbury the varieties of pear-trees which seem to be most susceptible to fireblight are Marie Louise and Glou Morceau.